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CIVIL ENGINEERING

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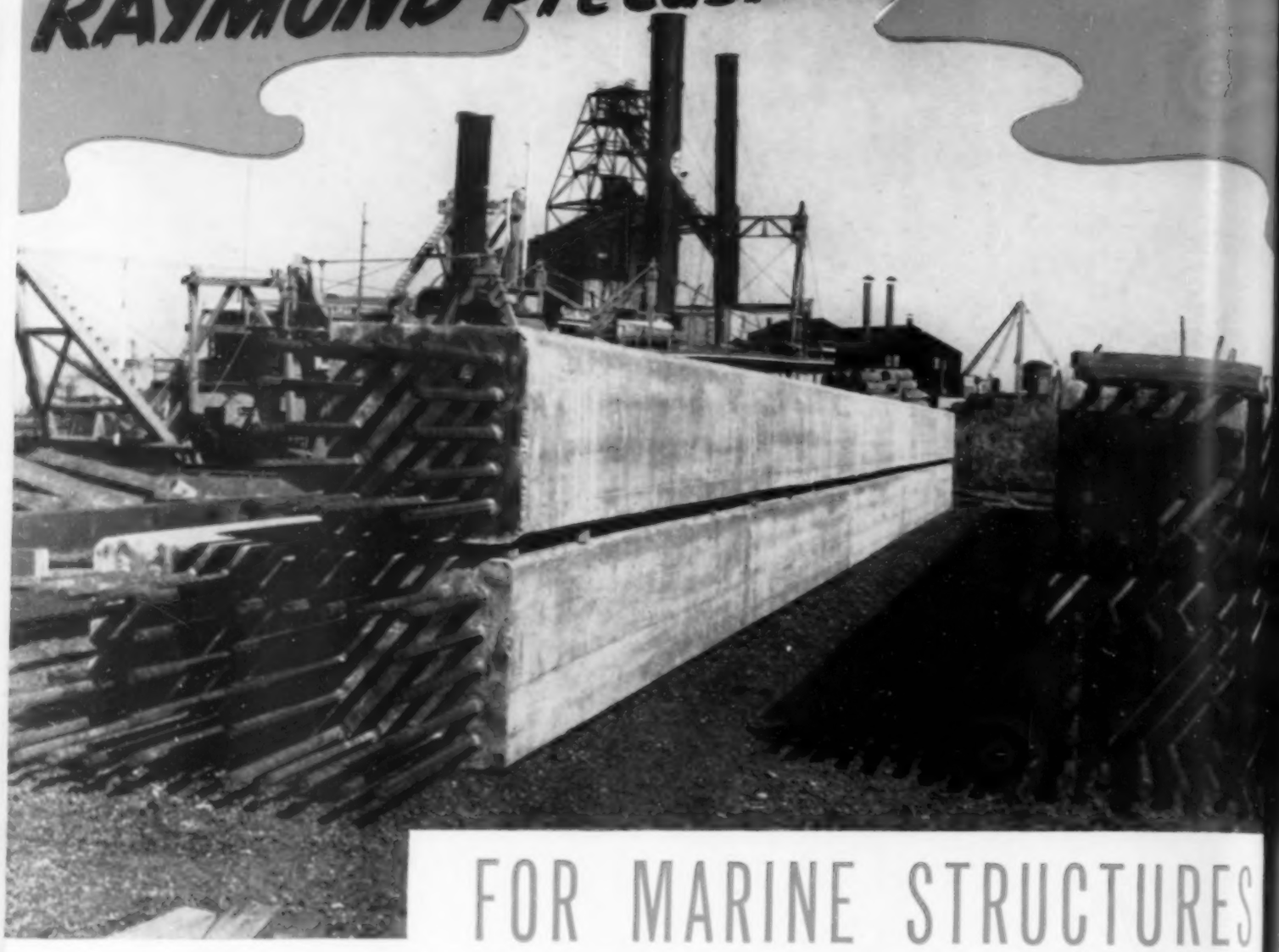

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineering Education in Perspective

From a Symposium Sponsored by the Northwestern Section, April 7, 1941—One of a Series Conducted Throughout the Country at the Suggestion of the Society's Committee on Engineering Education

By LORENZ G. STRAUB, M. AM. SOC. C.E.

PROFESSOR OF HYDRAULICS AND DIRECTOR OF ST. ANTHONY FALLS HYDRAULIC LABORATORY, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

THE highly accelerated growth of the world's scientific knowledge, and the widespread dissemination of this information during recent decades, has brought about far-reaching changes in the civilization in which we live. I say "civilization" as distinguished from "culture."

We have doubtless made great strides in civilization, that is, in advancing our material and social well-being. But as to culture—the intellectual aspects of civilization, that enlightenment which should be acquired by intercourse with what is best in civilized life, particularly as evidenced in delicacy of taste and nicety of breeding—real progress is lacking. In fact, there has been a marked retrogression. Witness the growing social unrest and the international upheavals of the present generation.

The Engineer at Fault?~In a spirit of self-vindication one might, as an engineer, be tempted to disclaim any responsibility for this condition. Why hold the engineer responsible? To answer this question, let us consider for the moment the broader definition of engineering—the art of applying natural resources in conformity with the laws of nature, for the use, convenience, and benefit of man. If this definition is accepted, the social impact of technological development becomes a decided responsibility of the engineering profession. Great technological accomplishment is a dubious thing for the engineer to congratulate himself on, if from this very achievement there results a retrogression in the cultural and moral well-being of mankind.

To be capable of accepting the responsibility that is implied in the broader definition of the profession, a leader in engineering must be a true statesman, a leader of people. He should put into effect his plans for major engineering development only after, by deliberation, he has assured himself that his handiwork is for the public good. To be sure, this requires a great breadth as well as depth of knowledge, combined with wisdom and a capacity for discernment attainable by few individuals.

Only a Beginning.~This is the engineer in his fullest development—the ideal engineer—the kind of individual who is sorely needed in this troubled technological age. But let us not fool ourselves into believing that by a unique choice of courses in an engineering curriculum, and a sufficient number of years of training, we can take the raw material and turn out engineers of this type on a mass-production basis. On the other hand, let us not shrink from recognizing the fact that a suitable course of training in his formative years can do much to stimulate the development, in the young engineer, of innate qualities of leadership, and can provide sufficient depth of technological and humanistic knowledge to serve as a basis for growth during subsequent years.

The college-trained engineer, at the completion of his course, no matter how intensive or broad the curriculum, is still a neophyte in his profession. He has, or should have, an engineering personality produced by training and development of certain native abilities; but in no sense is he a mature engineer—not even after five, six, or seven years of academic work.

Meeting Modern Needs.~Let us admit at the outset therefore, that a well-planned college course, of any number of years, can do no better than produce graduates from which mature engineers may develop. It is not so much the product at graduation with which we are concerned; it is rather the potential contribution of a mature engineering personality some years later.

What, then, are the needs of our social order that should logically be filled by the engineering profession? Modern engineering enterprise achieves its results by the association and harmonious working together of people of greatly varied knowledge and abilities. The leaders of such enterprise must be men who have attained real professional stature. They should be men of high technical knowledge, but most certainly they should have developed a perspective on humanistic and social problems. There are, however, many technical skills needed in engineering enterprise which require intensive training and experience. The diversity and scope of technical knowledge required in a project—such as a hydroelectric development—can no longer be encompassed by one man, however extensive his training and experience.

Concept of the Engineering Fraternity.~A great range of scientific knowledge and technical abilities is required—so much so that engineering educators are generally

agreed that a well-defined caste of professional engineers is difficult, if indeed at all possible, to isolate, at least to the extent found in the medical and legal professions. Rather the engineering profession is to be thought of as a vaguely bounded nucleus, within a much larger sphere, frequently referred to in educational parlance as the "engineering fraternity." Its members are in the process of attaining legal status through registration as "professional engineers."

There is thus a whole gamut of activity within the realm of engineering. To be sure, all this work is not, strictly speaking, engineering. Yet it all definitely depends upon the engineer's creative enterprise, and therefore should not be swept aside by the engineer as being outside his province of activity.

A Larger Vision Needed.~How, then, within our present educational system, can engineering training best serve the interests of society? In the course of the past two or three decades discoveries in science and technological development have become so great that there have gradually been introduced manifold divisions and further subdivisions of technological subjects in our engineering colleges. Time-consuming laboratory courses have been continually condensed and now and then eliminated to make room for so-called theoretical courses. To meet the demands of industry, many specialized training courses have been added. The number of credits required for graduation in a four-year engineering course has been increased in order to meet the need for more specialized technical training. Indeed, at least until recently, so-called non-technical courses have been given very little consideration. Occasionally the efficacy even of a course in English for engineers has been questioned.

Although most engineering colleges have allowed for a limited number of elective credits, in many cases, if not in the majority, students fulfill them in further specialized technical subjects. This procedure does not give the best results, notwithstanding the fact that the student receives a good training in the analytical processes of attacking an engineering problem, and acquires considerable factual information needed by the practicing engineer. Most frequently the humanistic-social phase of his training has been seriously neglected.

Year Longer, as an Expedient.~The need of a five-year course has often been suggested, unfortunately all too often with the thought of including more technological courses which otherwise would have to be neglected. To be sure, the so-called "non-technical" courses are ordinarily suggested as a desirable addition. However, even here too little regard has been given to choice of courses, or to the educational pattern of the student's training in the humanities. Thus the five-year course falls short in the same way as the four-year course.

The argument usually put forth in defense of a concentrated technological curriculum is that such subjects are not readily mastered outside of school, while the non-technical or humanistic-social subjects can be learned independent of special instruction. There is a fundamental fallacy in this kind of argument; it lies in the fact that after reaching maturity a man tends to stick tenaciously to his early habits of thought and action. It is necessary to present to the immature engineer the proper basis for a study of the humanities in some detail if he is to be able later to profit by outside study in this field.

Debunking an Engineering Myth.~I cannot agree that our much glorified "engineering approach to a problem" is the panacea which the world has been awaiting. In fact, the technical procedures of the engineer, where not tempered by perspective gained in studies in the humanities, definitely handicap him in his efforts to unravel social problems. He fails to recognize that the structure of our social-economic order is dynamic and constantly changing—fundamentally different from technology. The ever-changing problems of human affairs do not lend themselves to fixed formulas as technology does, encompassed as it is by the rigid laws of the physical sciences.

But what of the procedure that has been variously proposed, and occasionally introduced, of providing two years of pre-engineering training in an arts college before the three- or four-year course in engineering? This arrangement has a number of inherent shortcomings. First, it fails to satisfy the desire of the student entering college to become familiar with some of the processes of engineering at an early date. Second, it assumes that less maturity is required for the humanities than for engineering. And third, it fails to allow for a systematic sequence which will provide greater possibilities for mature thought in social matters.

The Employer's Specification.~The engineering college of today is beset with many difficulties when it attempts to introduce the type of training here suggested. The employer of engineering graduates most frequently seeks men of vocational skill rather than of potential professional stature. He wants as nearly as possible a man with finished technical training. If the engineering college sets up its pattern of courses to provide adequate training in the humanities, a four-year course cannot include as much specialized training as the present overcrowded engineering curriculum.

In order to supply the needs of society there should be a greater diversification of training patterns in engineering. The best advantage of society, and of the individual as well, would be served by training men in accordance with their natural endowments variously in two-year concentrated technical courses, and in four-year engineering courses with probably a better balance of both scientific-technological training and humanistic-social, followed by graduate work of more specialized character.

Many Needs in View.~Let us not attempt to conventionalize engineering training by setting up unnecessary, artificial restrictions. Engineering enterprise requires the coordinated efforts of men of innumerable patterns of training and abilities. More men are needed in the well-trained technical classification—engineering technicians—and more also in the engineer-management group and in places of influence in civic and national affairs. The advances being made in science and technology are so vast and rapid that under no circumstances can an engineering graduate consider that he has once and for all satisfied all educational requirements.

Keeping abreast of the times is a personal responsibility of the engineer to himself in particular, and to society in general. The engineering college can assist him in his initial training and, if he cooperates, can also provide assistance in further study after graduation by night classes, correspondence study, and other methods, to put him abreast of the specialized information he needs in his particular technological field.

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Work of the Civil Engineer Corps of the Navy

Development of Outlying Bases as Well as Expansion of Existing Shore Establishments Included in Program

By J. J. Manning, M. Am. Soc. C.E.
Captain, (CEC) U.S.N., Bureau of Yards and Docks, Washington, D.C.

NOT so long ago, our sea forces made up a scant one-ocean Navy, hampered by limiting treaties and small appropriations. They are now a two-ocean navy, equipped, manned, operating, and growing stronger every day. But they cannot function without land support by the Naval Bureau of Yards and Docks, which is administered by the Corps of Civil Engineers. This shore establishment builds and operates the bases used to sustain the forces afloat and provides the facilities for training all naval personnel. In this paper, presented before the general session of the Chicago Meeting, Captain Manning describes the work of this important branch of our armed forces.

THE Naval Shore Establishment is an active business organization representing an investment of more than two billion dollars and including such facilities as navy yards, submarine bases, destroyer bases, air bases, supply, fuel and ordnance depots, gun and powder factories, radio stations, research and experimental laboratories, training stations, naval hospitals, marine barracks, and the famous educational institute, the U.S. Naval Academy. It must be recognized, to adequately comprehend the magnitude of the naval shore establishment, that the various facilities enumerated are not located in a single area, but must all be duplicated, not only at strategic points throughout our own continental limits and Alaska, but in outlying territories and possessions as well. Recently it has also become necessary to provide them in neighboring British possessions.

These various developments are known in the Navy as "Public Works of the Navy." The Bureau of Yards and Docks is charged by statute and departmental regulations with the design and construction of all public works and public utilities of the Navy, and the tremendous expansion of these facilities is now being carried on under that Bureau, whose activities are administered by the Corps of Civil Engineers of the Navy. The Bureau has as its administrative head the Chief of Bureau, who also has the title of Chief of Civil Engineers. The present incumbent is Rear Admiral Ben Moreell, (CEC) U.S.N., M. Am. Soc. C.E. The Corps of Civil Engineers is a commissioned staff corps, and all its commissioned officers hold a degree of civil engineering from recognized colleges and universities.

The basic defense construction program now under way may be said to have really started—except for work in Alaska, Hawaii, and Puerto Rico, which began in 1939—with the passage of the Naval Appropriation Act of June 11, 1940. From that date until the end of the fiscal year June 30, 1941, a total of $682,245,192 had been covered in contracts awarded.

Some idea of the magnitude of the nation's present undertaking in naval defense may be gained by comparing peak activities of 1917–1918 with those of the present emergency. Contracts awarded through the Bureau of Yards and Docks from July 1, 1917, to June 30, 1918, totaled $89,092,725. In the month of July 1941 alone $60,481,000 worth of contracted work was paid for. In short, the contract work of six weeks now approximately equals that of an entire year of the previous World War.

Not only has there been expansion in the older recognized features of the Navy—primarily surface craft and submarines, but also in a new feature—aircraft, which has un-

Shipways Have Had to Be Rehabilitated to Accommodate Modern Design

RECOMMISSIONING PIERS ARE NECESSARY FOR USE IN SERVICING DESTROYERS

dergone enormous expansion. The development of aircraft and its proved capabilities for action at long range have focused attention on the need for outlying bases to properly protect our coast lines, heretofore considered secure behind the barrier oceans.

Realizing this situation, the Navy Department, under the Act of May 17, 1938, created a body known as the Hepburn Board, for the purpose of investigating and reporting on the need, for purposes of national defense, of additional submarine, destroyer, mine and naval air bases on the coasts of the United States, its territories and possessions. This board, in a report dated December 1, 1938, recommended the development of air and submarine bases on the continent and at outlying points off both coasts, in Alaska and Panama. Congressional action on this matter was exceedingly rapid, and the Bureau was called upon immediately to transform the recommendations of the Board into estimated costs.

Realizing the difficulty of bidding on work outside the continental United States, the legislation appropriating funds for the accomplishment of part of the Hepburn Board's recommendations carried with it the authorization to negotiate contracts for such work. The contract which the Bureau developed for this work is of the cost-plus-a-fixed-fee type, in differentiation from the cost-plus-a-percentage type, which was prevalent during the last war. The Bureau considers the new type of contract more desirable than the older type. In essence, the type of fee contract used permits what is in a certain sense a partnership between the Government and the contractor for accomplishing a definite purpose.

The law requires that the Bureau negotiate with at least three contractors of its own selection, and the ultimate selection of a contractor or group of contractors is entirely in the hands of the Bureau. This partnership is one of mutual understanding and agreement and not a combination fixed as a result of competition or chance.

The fixing of a definite fee beforehand eliminates the elements of gambling and bickering. Under this type of contract the Government assumes all hazard, but of course does not exempt the contractor from accidents or damages resulting from his own gross negligence. It is considered that this provision is eminently fair, as the Government is in far better position to assume hazards than the contractor. And in the final analysis the Government, in assuming the hazards, pays only for the hazards incurred, whereas if the contractor assumed them, the Government would, either directly or indirectly, pay for the hazards whether they occurred or not.

Immediately upon the appropriation of funds, the Bureau undertook negotiations for work at three important outlying areas, that is, Hawaii in the mid-Pacific, Alaska, and Puerto Rico in the West Indies. Necessary press releases brought ready responses from literally thousands of contractors, setting forth their qualifications and organizations, financial standing and experience records, justifying their acceptance as contractors for these negotiated contracts. A total of more than twenty-eight hundred such names has been received. These records were thoroughly reviewed by the Bureau, segregated into appropriate classes, and the statements contained in them verified as desired.

SUCCESS OF PROGRAM DUE TO VARIOUS FACTORS

A number of factors have contributed to the speedy prosecution and success of this large construction program:

1. Much of the work was planned long in advance and much of the basic design work was already completed.
2. Standards had been developed for layouts; and types, plans, and specifications were ready.
3. A well-trained nucleus organization, which could be rapidly expanded, had been developed in the Bureau and in the field.
4. By decentralization and the granting of broad authority and full responsibility to the officers in the field, much delay has been avoided.
5. The required designing, detailing, and engineering beyond the capacity of the Bureau's organization and field forces have been accomplished under contract by private architectural and engineering concerns. This procedure has made available a large reservoir of professional talent throughout the country.
6. The cost-plus-a-fixed-fee type of construction contract, by its flexibility, has enabled the Navy to initiate the work rapidly and to prosecute it energetically.
7. Last but perhaps most important, a spirit of

SPECIAL SHOPS ARE NECESSARY TO BUILD AND SERVICE TURRETS AND SUPERSTRUCTURES

loyalty, cooperation, enthusiasm, and pride in the work has been developed not only among the Navy personnel but also among the private architects, engineers, and contractors, all of whom are working together as partners to accomplish a vital national defense effort.

Undoubtedly some quality and economy is being sacrificed for speed. But speed is paramount, and it is safe to say that a national defense facility somewhat imperfectly designed and constructed, but available when needed, is better than one which approaches perfection but is only in the blueprint stage.

QUARTERS FOR NAVAL AVIATION CADETS ARE PROVIDED BY THE CIVIL ENGINEER CORPS

Immediately following the receipt of appropriations, contracts were negotiated for work in the mid-Pacific, Alaska, and Puerto Rico. In subsequent legislation Congress extended the use of the cost-plus-a-fixed-fee contract to continental stations. Immediately thereafter, fee contracts were awarded for work at several new air stations, and for many other extensions and improvements at existing stations.

It should be pointed out that, in these negotiations, at no time was there any competition as regards the fee. The contractor was recommended by the Board without reference to the fee, and after selection had been made, the Board recommended to the Chief of the Bureau what it considered the fee should be, the final fee being fixed by the Chief. To date the Bureau has negotiated 150 fee contracts, with a total estimated cost to July 31, 1941, of $860,300,000. When time and available facilities will permit the preparation of complete plans, specifications, and bidding data beforehand, the present policy of the Bureau is to utilize lump-sum contracts, awarded as a result of competitive bidding.

WORK AT FAR-DISTANT STATIONS

The largest of our fee contracts is that for work in the Pacific, which has become known as our Pacific Air Base contract. This contract, held by a group of eight large contracting concerns of national reputation, totals approximately $239,000,000. It includes work at several locations on the islands of Oahu and Maui in the main Hawaiian group, and at the outlying islands of this group—separated from the main Hawaiian group and from one another by from 900 to 1,100 miles. These islands are small coral atolls with no closer neighbors than Hawaii and with no human habitation except for cable keepers and Pan American Airways personnel.

Climatic conditions in Alaska differ from those in the mid-Pacific. Isolation is almost as complete as regards availability of materials, although with the exception of Unalaska there is other habitation in the general vicinity of the Alaskan stations. Of the two, I would say that climatic conditions in Alaska more adversely affect operations. Full advantage is taken of the longer daylight hours during the summer months, but there is a correspondingly shorter work day in the winter. In addition to our own Naval developments at Alaskan stations, we have constructed the quarters to house the Army personnel protecting the air stations.

In carrying on our operations in Alaska, at each of the stations we have purchased an old steamship and after fitting it out in the United States have utilized it as a floating barracks. This procedure has many points to recommend it: first, all work incident to its preparation is done in the United States; second, it is a self-contained unit having full galley, mess-hall, laundry, and sleeping facilities. It is ready for operation the day it arrives. It can be removed on completion of the work. In some instances, the ship was able to proceed to its destination under its own power.

The development in Puerto Rico differs from that in Hawaii and Alaska in that all of it is taking place practically within, or adjacent to, one main center of population. There has thus been no necessity for the establishment of camps and the importation of as many construction personnel. However, it was necessary to fill by hydraulic methods practically the entire site on which the station was developed.

Much publicity has been given to the treaty arrangements whereby the United States has been permitted to develop bases on British possessions in this hemisphere. These localities, being populated and not so remote from our eastern coast, do not present the same problems as Alaska and Hawaii. They do, however, present problems of a different nature—such as the utilization of local labor and local import duties.

Following the disarmament treaty of 1922, and until the recent construction program, battleship construction in the United States has been dormant. Naturally, in this interval of eighteen years many changes have taken place in the features of battleships, but at the same time there had been no expansion or development of the facilities for building them. Other than at some of the major Navy Yards and three commercial plants, such facilities were in fact non-existent.

The shipbuilding ways built during the last war for battleship construction were not of adequate size to accommodate the ships now projected, nor was the basis of design adaptable to present work. The heaviest weights used in hull construction in bygone days were applied after launching; present designs require the placing of these weights before launching. Likewise the weight concentrations have been moved from the center

STRUCTURAL-STEEL SHOPS FACILITATE SHIP CONSTRUCTION

MACHINE SHOPS BUILT AND MAINTAINED BY THIS BRANCH OF THE NAVY ARE COMPLETE IN EVERY DETAIL

line to the exterior of the ship, requiring almost a complete rebuilding of shipways to accommodate the new load distributions. This feature means that the weights of ships at launching are far in excess of any heretofore experienced.

Strengthening of the ways was a construction problem of the first order, necessitating the placing of hundreds of additional piles under existing structures and at the same time strengthening of existing concrete deck structures. In addition to the ways proper, the overhead traveling cranes had to be provided with increased capacity. This was done by redesigning them, utilizing alloy steel instead of structural steel, and spreading the wheel bases of the supporting trucks.

Fixed hammerhead cranes with a capacity of 350 gross tons, at 190-ft radius and 135-ft vertical lift, have been provided. On the top chord of the horizontal boom of these cranes a second traveling jib crane of 15-ton capacity operates at a 60-ft radius. Several 50-ton jib cranes at 105-ft radius and 90-ft vertical lift have also been provided. We are now building similar cranes of 75-ton capacity, and traveling gentries of 200-ft span, and 90-ft vertical lift, with two 75-ton trolleys each, for use on shipbuilding docks.

To provide additional shipbuilding facilities for battleships, dry docks have been adopted in lieu of the customary inclined ways. Dry-dock construction was practically at a standstill from the termination of the last war until 1937, when the Navy Department resumed dry-dock building. Since that time we have entered upon a very extensive dry-dock construction program. The general battleship graving docks that have been provided at repair yards are of the largest type yet built.

This program now includes several shipbuilding docks and repair docks. These docks are of reinforced concrete construction. Where foundation conditions permit, they are invariably built in the dry by means of cofferdams. In some instances the areas can be completely unwatered and construction carried on by merely providing a cofferdam across the entrance of the dock site. Such conditions exist at Puget Sound and San Diego. At other locations a cofferdam is used to completely surround the site, usually with interior bracing. A third method—to construct the dry dock in the wet—is followed where foundation conditions are such that the site cannot be unwatered. The Bureau is also engaged in the construction of several floating docks.

The Bureau has pioneered in the application of welding to its various projects. It is considered that much has been accomplished in the design of shop buildings with welded rigid frames. Cooperation between the Bureau and private engineering concerns has led to the adoption of the best design ideas of both, resulting in the development of the most desirable and economical type of structure, which has been used repeatedly with considerable savings.

At present the Bureau's current expenditures, that is, actual cash disbursements, total $60,000,000 per month. It is realized that to state its accomplishments in terms of dollars alone might well be misleading—they are at best only indicative. It is far more comforting to say that this extensive construction program was initiated immediately, as soon as funds became available, and has been pursued with diligence and speed, with the result that required facilities are now available.

It is our mission to provide the facilities needed to maintain the forces afloat, to train the personnel for the forces afloat, and in general to keep ahead of the demands of the forces afloat. This we have successfully accomplished in the past; this we will continue to do in the future. We consider this accomplishment a matter of justifiable pride to the civil engineering profession whose industry and experience have made it possible, and we of the Navy are deeply grateful to all who, in some way or other, have contributed to its success.

350-TON HAMMERHEAD CRANE HANDLES THE HEAVIER UNITS NEEDED FOR BUILDING AND SERVICING SHIPS

NAVY YARDS MUST PROVIDE AMPLE SPACE TO DOCK ALL TYPES OF NAVAL CRAFT

Progress of TVA Power Program

Far-Reaching Development Started in 1933 Will Attain Peak in 1944

By HARRY WIERSEMA, M. AM. SOC. C.E.

GENERAL OFFICE ENGINEER, TENNESSEE VALLEY AUTHORITY, KNOXVILLE, TENN.

POWER demands for national defense and the extensive use of the Tennessee Valley for industrial development, as well as for the manufacture of munitions and for army training grounds, have again focused the attention of the country at large on the work of the Tennessee Valley Authority. To gain the proper perspective, it is necessary to view this subject by looking backward to 1933 and forward to 1944. This comprehensive view was originally presented by Mr. Wiersema before the Baltimore Meeting of the Society, and for this paper it has been revised and brought up to date as of the end of 1941.

WHEN the Tennessee Valley Authority was organized in 1933 and given the mandate to develop the Tennessee River for navigation, flood control, and hydroelectric power, the present degree of development could scarcely have been dreamed of by the most optimistic of the Authority's engineers. In 1933 the system consisted only of Wilson Dam at Muscle Shoals with a continuous capacity of 39,000 kw, while the anticipated 29-plant system of 1944 will have an installed capacity of over 2,700,000 kw and a continuous power output of over 1,500,000 kw. Of the factors that have contributed to this growth three are of major importance: the purchase of the entire facilities of the Tennessee Electric Power Company in 1939, the national emergency defense program initiated in the summer of 1940, and the rapid increase in power demand during the past few years—the expected result of the low rates for power established by the Authority soon after its organization in 1933.

In 1933 the power possibilities of the Tennessee Valley had scarcely been scratched. The existing plants in the Valley had a total installed capacity of 668,000 kw and a total continuous power available of only 174,000 kw, the bulk of which was from privately owned plants. In fact only one, Wilson Dam, was under Government ownership. Of the privately owned plants, there were four belonging to the Tennessee Electric Power Company (Hales Bar, Ocoee No. 1, Ocoee No. 2, and Blue Ridge); three belonging to the Aluminum Company of America (Calderwood, Cheoah, and Santeetlah); and one belonging to the Carolina Power and Light Company (Waterville).

One of the most noticeable facts concerning the Wilson plant is the large amount of installed capacity compared with the small amount of continuous power available. The latter is limited by the low flows of 1925, which totaled about 6,000 cu ft per sec during the critical dry period, including an allowance for storage regulation by privately owned reservoirs built subsequent to 1925. At that time there was practically no regulation of the flow of the Tennessee River, and the actual minimum flow in that year was only 4,000 cu ft per sec. Obviously the most efficient development from the standpoint of power would be the regulation of flows through storage. Theoretically, if complete regulation could be had on the drainage area above Wilson Dam of some 30,000 sq miles, with an average annual runoff of about 1.69 cu ft per sec per sq mile, this minimum flow could be increased to about 52,000 cu ft per sec, which would mean increasing the continuous power available more than 8 times, or to about 330,000 kw. Of course such complete regulation is entirely impossible.

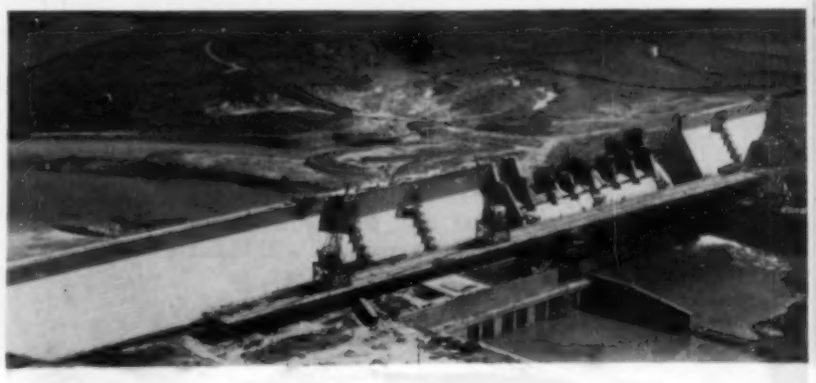
A study of the Tennessee Valley watershed (Fig. 1) shows, however, that there are great possibilities for upstream regulation. The extreme eastern end of the Valley is high and mountainous and contributes a large part of the flow in the main river, which extends for some 650 miles mainly through the western half of the Valley, before emptying into the Ohio at Paducah. The total fall from the head of the river at Knoxville to the mouth is about 512 ft. In the eastern half there are five main tributaries—French Broad, Holston, Clinch, Little Tennessee, and Hiwassee—which would seem to lend themselves fairly easily to storage projects. These tributaries have a combined drainage area of 18,660 sq miles and their total average annual runoff in a typical 12-year period was 31,300 cu ft per sec, or 21,600,000 acre-ft.

With complete regulation of these tributaries it would appear that the minimum flow at Wilson Dam could be increased to something over 30,000 cu ft per sec. Here again the maximum theoretical storage is of course impossible of obtainment. However, studies on the first of these tributaries to be developed, the Clinch, by the construction of Norris Dam, indicated the possibility of regulation up to 70% of the theoretical maximum.

It would seem that if the entire head in the Tennessee River could be utilized and the minimum flow at Wilson Dam increased to 30,000 cu ft per sec, a total continuous power of 925,000 kw would be possible for the main river system. In addition to this, of course, the power plants at the storage dams would add a considerable amount of primary and secondary power that could be primed by steam or by additional storage.

It is interesting to compare these possibilities with the actual plan of development by 1944. Carrying out the mandate to construct a 9-ft navigable channel in the Tennessee River from Knoxville to its mouth, seven main-river dams have been designed and are now completed or under construction, in addition to Wilson Dam and the acquired Hales Bar plant. It so happens that the interests of navigation coincide exactly with those of power for these dams, because a high dam, creating a deep reservoir, is most beneficial for both.

The dams now completed or under construction on the main river are Kentucky, Pickwick Landing, Wilson, Wheeler, Guntersville, Hales Bar, Chickamauga, Watts



CHEROKEE DAM ON THE HOLSTON RIVER
Authorized July 1940; Dam Closed and Reservoir Storage Begun Dec. 1, 1941

These developments planned by the Tennessee Valley pletion at Watts Bar, and an additional 120,000 kw at the

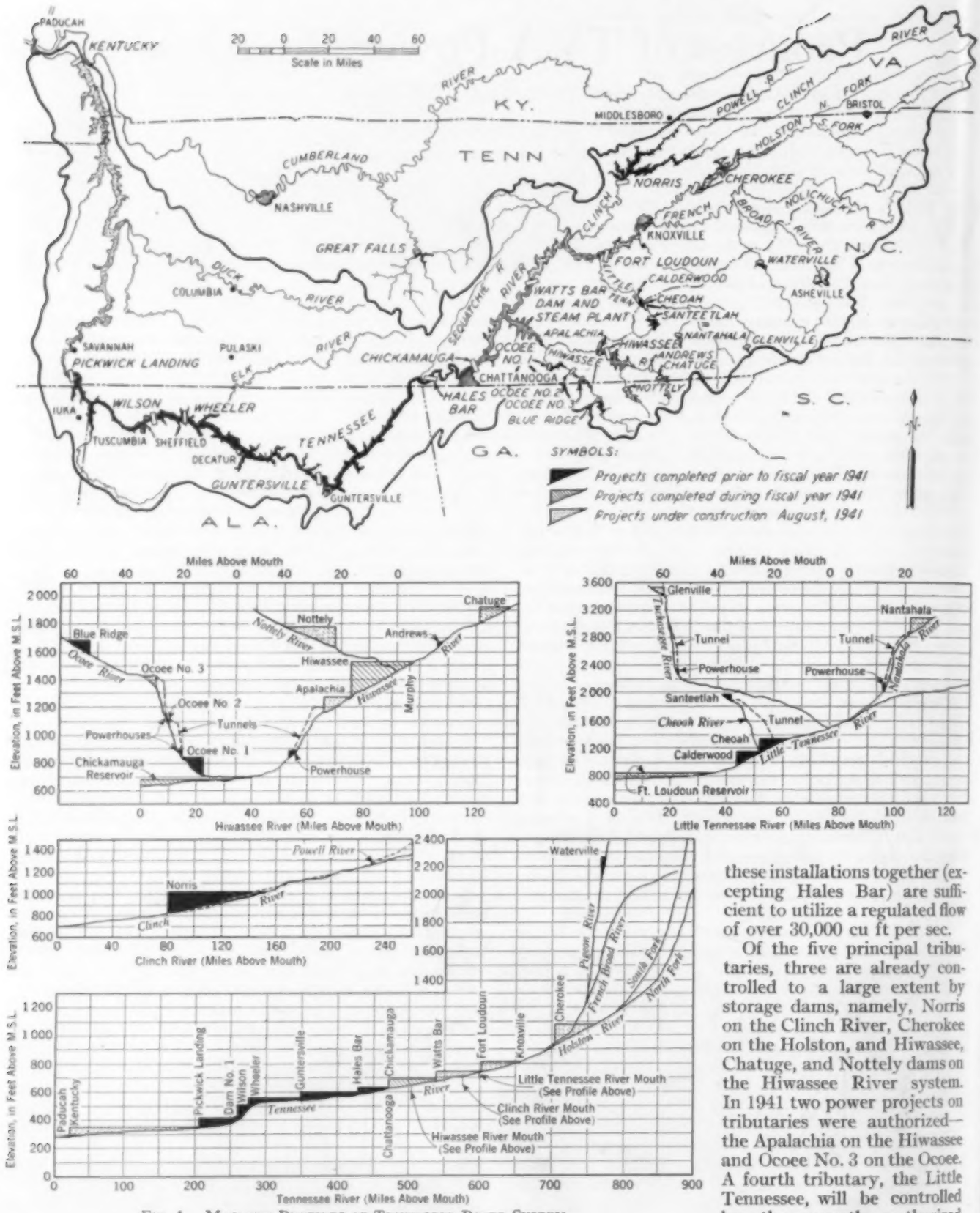


FIG. 1. MAP AND PROFILES OF TENNESSEE RIVER SYSTEM

Bar, and Fort Loudoun. These will have an installed capacity of 63 units totaling 1,453,000 kw, with an average available head of 493.5 ft—only 19 ft less than the total drop. This 19-ft leeway is necessary for fluctuations of the reservoirs for flood and malaria control. All these installations together (excepting Hales Bar) are sufficient to utilize a regulated flow of over 30,000 cu ft per sec.

Of the five principal tributaries, three are already controlled to a large extent by storage dams, namely, Norris on the Clinch River, Cherokee on the Holston, and Hiwassee, Chatuge, and Nottely dams on the Hiwassee River system. In 1941 two power projects on tributaries were authorized—the Apalachia on the Hiwassee and Ocoee No. 3 on the Ocoee. A fourth tributary, the Little Tennessee, will be controlled by the recently authorized Fontana Dam. The Holston River storage is being increased by two additional dams—one on the Watauga River and one on the South Fork of the Holston River. With the exception of Chatuge and Nottely dams, these tributary dams are power projects, and have a total installed capacity of 767,000 kw.

These developments planned by the Tennessee Valley Authority have been increased by the purchase in 1939 of the entire system of the Tennessee Electric Power Company, consisting of Hales Bar Dam on the Tennessee; Ocoee No. 1 and Ocoee No. 2 on the Toccoa-Ocoee; Blue Ridge Dam on the Toccoa; and Great Falls Dam on Caney Fork in the Cumberland River watershed. This represents 23 units with an installed capacity of 137,300 kw, and 57,000 kw of continuous power.

Also by this acquisition, the Authority was placed in possession of steam plants at Hales Bar, Nashville, and Parksville of 101,000-kw installed capacity with a continuous power output of 88,000 kw, in addition to a steam capacity of 54,000 kw made available through contract with a privately owned steam power plant at Memphis, Tenn. Also there was placed in service the Sheffield steam plant of 60,000-kw capacity, which had been held in reserve for a national defense emergency. This emergency developed far earlier than anyone had anticipated, so that by the summer of 1940, when the Aluminum Company of America demanded a greatly increased output, it became necessary, in order to supply the additional power required, as well as economically to firm up the available secondary hydroelectric power, to install additional steam plants in the TVA system. In July 1940 Congress appropriated funds for the installation of 120,000-kw steam capacity, which is now nearing completion at Watts Bar, and an additional 120,000 kw at the Watts Bar plant has since been authorized, and is now under construction. An additional 40,000-kw steam unit for the Sheffield steam plant has also been recently authorized by Congress. These will bring the total steam capacity in the TVA system to 495,000 kw, including that made available by the Memphis contract, and 476,000 kw when the Memphis contract is reduced on June 28, 1942. These figures do not include a small amount of capacity in minor acquired plants.

The Authority also has facilities for interconnection with the private power utilities in this vicinity, such as the Alabama Power Company, the Carolina Power and Light Company, Kentucky Utilities Company, Arkansas Power and Light Company, Tennessee Power and Light Company, the Appalachian Electric Power Company, the Aluminum Company of America, and others.

The total power that will be available by 1945, therefore, in main-river

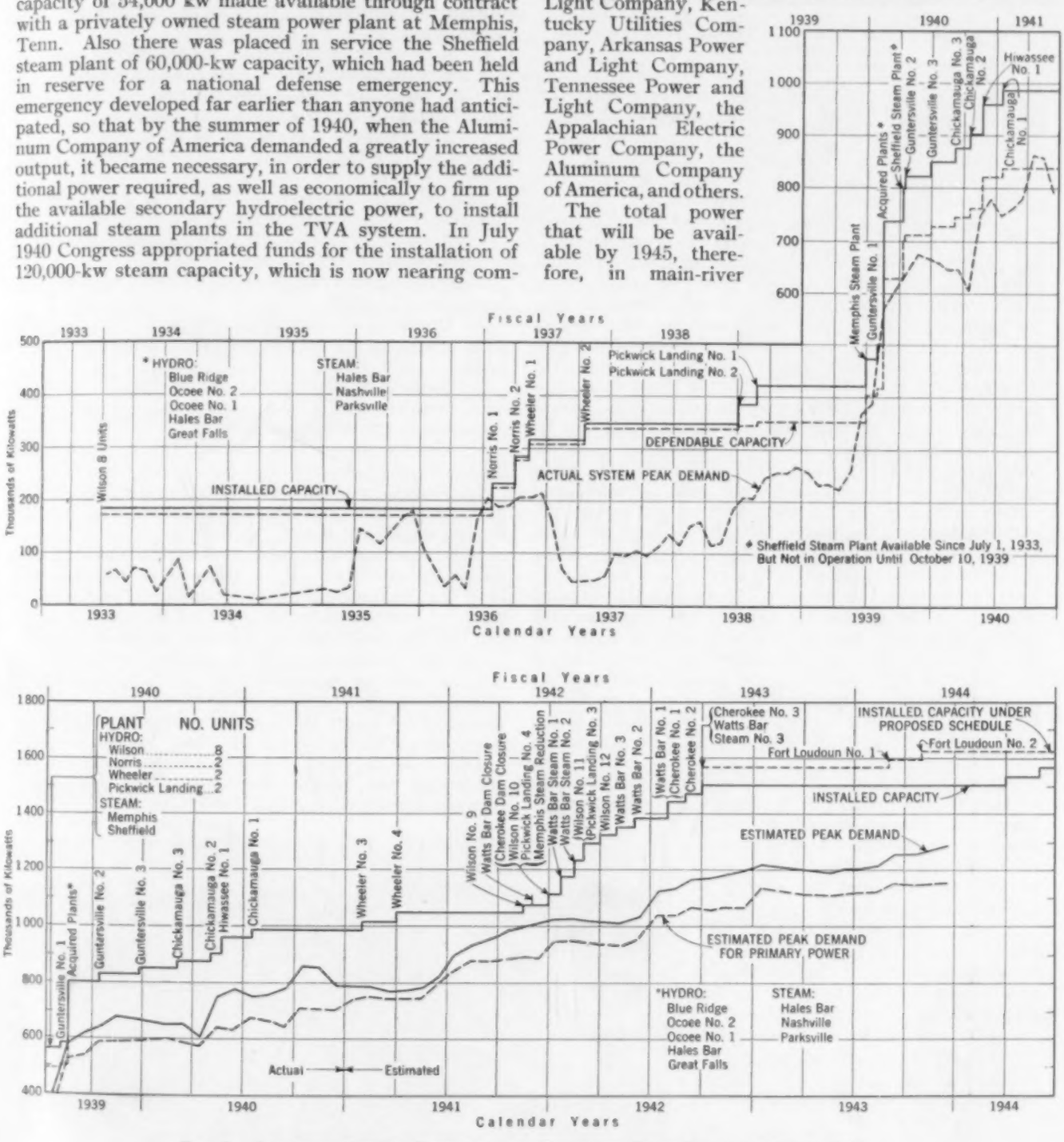


FIG. 2. AVAILABLE SYSTEM CAPACITY AND ESTIMATED PEAK DEMAND 1933 TO 1944
(Recently Approved Projects, Which Are Mentioned in the Text, Are Not Included in This Chart)

WATTS BAR STEAM PLANT ULTIMATELY WILL PROVIDE FOUR 60,000-KW UNITS

storage and TVA purchased plants, together with the plants authorized by the national defense program, but excluding minor plants, will amount to an installed capacity of 2,734,500 kw, and a maximum continuous output of 1,516,000 kw, based on a dry year, and of 1,700,000 kw, based on an average year.

Another feature in the development of the Tennessee Valley system is the very rapid growth in power demand. Figure 2 shows the available system capacity and actual peak demand from 1933 to 1944, based on existing contracts and anticipated demands. It will be seen that in the early years, even after Norris and Wheeler were in operation, the demand was very low. However, it began to increase in 1938, grew rapidly through 1939, and after the acquisition of the Tennessee Electric Power Company properties reached 680,000 kw by the end of 1939. From that time on the increase was phenomenal. It can be seen that the enormous additional amount of capacity coming into the line in 1940–1942, is fully justified, and in fact it was the recognition of the need for additional power production for national defense that led to the authorization by Congress in July 1941 of two additional storage dams to increase the storage for regulation on the Hiwassee watershed by 400,000 acre-ft, and two purely power projects on this watershed to increase the installed capacity of the system by 100,000 kw, together with additional units in main-river plants with an additional capacity of 142,000 kw. An authorization by Congress in December 1941 called for the construction of three additional storage dams, two on the Holston watershed and one on the Little Tennessee; the installation of ten additional hydro units in existing dams, a fourth unit in the Watts Bar steam plant, and another unit in the Sheffield steam plant. If authorized, a pending request by the Office of Production Management for the Douglas Dam on the French Broad River would increase the storage for regulation to 6,000,000 acre-ft, the installed capacity to 2,815,500 kw, and the energy to 1,590,000 continuous kw.

As might be expected from an integrated system of this size, the cost trends are quite low. The latest report on the cost of hydro power, including depreciation but without interest, is about 0.6 mill per kwhr. The operating cost for steam generation, not including fixed charges, is 3.6 mills per kwhr, and including depreciation but not interest, 4.0 mills.

The fixed costs on the entire system are also correspondingly low. The total cost of the original multiple-purpose 11-plant hydroelectric system, based on allocations similar to those already approved by the President, is approximately $350,000,000; and the interest on this investment at 3% would add only about 1 mill per kwhr.

Some of the reasons why the Authority is able to produce power at so low a cost are:

1. The obvious economies in the interconnection of so large a natural system.
2. The inherent economy of a multiple-purpose project, where navigation and flood control justly stand a considerable part of the total expense.
3. The fact that the entire project was started in a period of depression, which secured low prices for initial construction and allowed the building up of an efficient organization for dam construction.
4. Economies resulting from the transfer of organization and equipment from one dam construction project to another, resulting from a construction program where similar dams are constructed in a logical sequence.
5. The inherent advantage of local control under federal sponsorship, operating with the flexibility of a private enterprise.

Reviewing the experience of the TVA during the last eight years, certain definite trends are discernible:

1. A very rapid increase in power demand, amounting to approximately 20% per year.
2. Expansion of the integrated system to absorb adjacent developments.
3. Construction of multiple-purpose dams as a part of an integrated system for navigation, flood control, and power.
4. Expansion of facilities for gathering hydrologic data, weather and stream forecasting, for use in the operation of the integrated system.
5. Construction of high-tension (154-kv) transmission lines in duplicate loops to connect all major plants.
6. Rapid expansion of power generating facilities for national defense, and the use of steam auxiliaries for firming secondary power.

It is of course impossible to forecast which of these trends will continue. It is, for instance, difficult to believe that such a rapid growth, stimulated as it is by low rates for power and by the national defense emergency, can continue indefinitely. Because of the fact that the Tennessee Valley Authority is pledged to the conservation of national resources, the present trend toward steam plants is an interesting development. It may be questioned whether this trend should not be reversed by developing supplementary upstream hydro plants and holdover storage reservoirs to firm secondary power, thus conserving the expendable resource of coal by the use of water power, a non-expendable resource.

WATTS BAR DAM ON THE TENNESSEE RIVER

General Features of Friant Dam

Construction Layout of an Important Unit in the Central Valley Project

By R. B. Williams, M. Am. Soc. C.E.

Construction Engineer, U.S. Bureau of Reclamation, Friant, Calif.

Friant Dam is well up in the running among the largest dams ever built. Located in the foothills of the High Sierras, it is an important link in California's Central Valley Project. The shape of the dam and the surrounding topography dictated the use of the temporary steel-trestle type of construction plant. This plant, like the cableway type, has been improved immensely in recent years over its early applications, and the design now in use at Friant represents the accumulation of good features gained from experience, combined with many outstanding details that are original with this project. This paper by Mr. Williams, the construction engineer, is the first in a series aimed to cover the leading construction features of this large undertaking.

One of the principal features of the Central Valley Project (Fig. 1) is Friant Dam, located on the San Joaquin River about 20 miles north of Fresno, Calif. It is a concrete gravity section, center overflow spillway type, with a maximum height of 320 ft, a crest length of 3,430 ft, a maximum base width of 268 ft, and a top width of 20 ft. The dam will contain approximately 2,150,000 cu yd of concrete. Approximately 1,300,000 cu yd of excavation was required to reach suitable foundations. The foundation rock is a hard, dense mica schist of excellent quality.

The structure will act both as a storage and diversion dam. Headworks for the 3,500-cu ft per sec Friant-Kern Canal will be located in the left abutment. This canal will run some 160 miles south to its terminus near Bakersfield. The Madera Canal, of 1,000-cu ft per sec capacity, receives its water through the right abutment and carries it approximately 40 miles north to its end at Chowchilla River. When the Central Valley Project is completed, most of the flow of the San Joaquin River will be diverted through these two canals to furnish a supplemental water supply to parts of five counties in the San Joaquin Valley. In this area most of the surface waters long ago were fully appropriated for irrigation and the pumping draft from thousands of deep wells is seriously depleting the underground supply.

All the normal flow of the San Joaquin River is now being used. The water stored in Friant Reservoir and diverted north and south through the two proposed canals must be replaced and this will be done by substituting water from the Sacramento River. Regulation of the flow of the Sacramento River by means of Shasta Dam and Reservoir will make water available for this purpose. It will be dropped down the natural channel of the Sacramento River to a point near Sacramento, and thence through a delta cross-channel to the head of the proposed Delta-Mendota Canal. Several pumping plants near the head of this canal will lift the water high enough so that it can flow by gravity southeast through the proposed Delta-Mendota Canal some 100 miles to Mendota Pool. It is at Mendota Pool that most of the waters of the San Joaquin River are now diverted for irrigation use. Delivery of Sacramento River water there will release San Joaquin River water for delivery out of Friant Reservoir into the Madera and Friant-Kern canals.

Friant Dam is just east of the town of Friant and just above the point where the San Joaquin River leaves the Sierra foothills and enters the San Joaquin Valley. The reservoir will be approximately 15 miles long and will have a gross capacity of 520,500 acre-ft. The live storage above the canal headworks, exclusive of that reserved for flood control, will be 360,550 acre-ft. The top 70,000 acre-ft in the reservoir is reserved for flood control. Actually the entire live-storage capacity of 430,550 acre-ft, in conjunction with canal diversions, will operate effectively for flood control purposes. The dead storage of approximately 90,000 acre-ft will form a permanent lake about ten miles long with excellent possibilities for boating, fishing, and other recreational uses.

The contract for construction of Friant Dam was awarded to the low bidder, Griffith Company and Bent Company of Los Angeles, on October 9, 1939. Actual work at the site was begun by the contractor on November 3, 1939. The first bucket of concrete was placed in the dam on July 29, 1940. Excellent progress has been made and by the middle of January placing of concrete was approximately 90% complete.

The specifications for construction of Friant Dam contain several unusual features, including the use of absorptive form lining on all exposed concrete faces, the addition of pumicite to the concrete mix for the dam except on the spillway faces, and limitations on concrete temperatures at the mixing plant, together with the usual provisions for cooling the concrete after it is

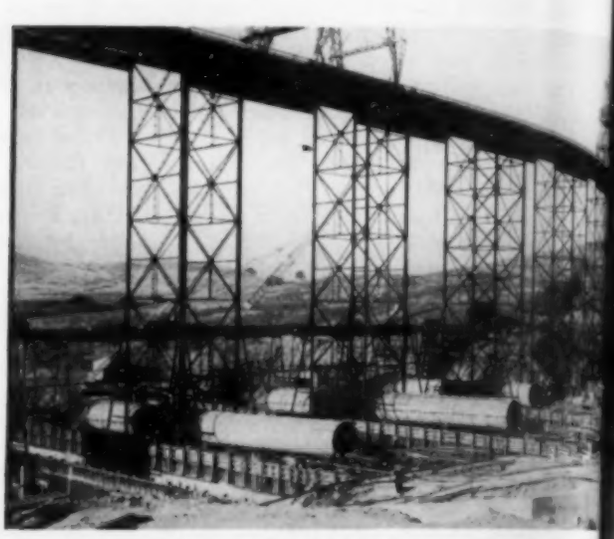
Trestle Erection Starts near Left End of Dam, June 17, 1940, as Foundation Excavation Is Completed

Left Abutment of Friant Dam Being Excavated Down to a Firm Foundation, June 1940

Relative Size of Construction Trestle Is Shown in Relation to Nearly Completed Dam

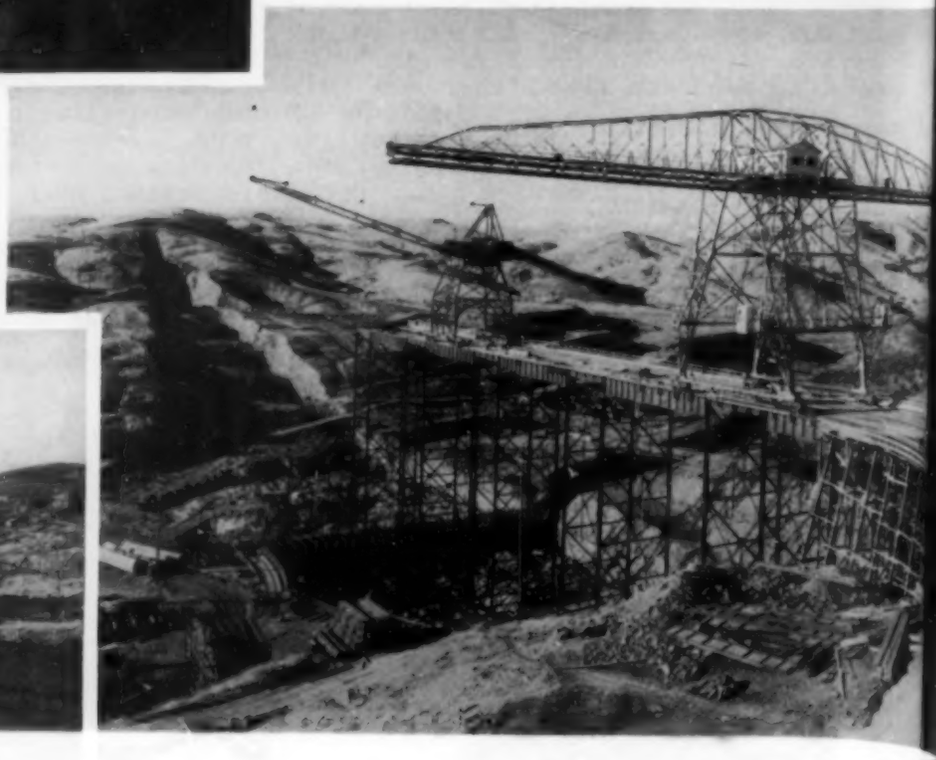
Stiff-Leg Derrick Places Concrete in Stilling Ba
This Was Beyond Reach of Cranes on Construction Tre

Concrete Plant and Trestle Were Constructed on Left Abutment While River Bottom Was Being Excavated



Tubular Forms for Temporary River Outlets Were Placed Between Legs of Temporary Construction Trestle

Whirley Crane and Hammerhead Being Assembled on Top of Steel Construction Trestle



Diversion Flume Was Blocked in March 1941, and River Diverted Through Three Temporary Outlets

placed, and grouting the contraction joints. These unusual features will be described in more detail in later articles.

Handling of the river during the construction period involved three steps. After excavation was carried to satisfactory foundations on the south side of the river, a temporary diversion flume was built across the foundation excavation and the river diverted into the flume in the late spring of 1940. The river channel was then unwatered and excavation for the dam foundation completed. The placing of concrete was then concentrated in the river section, and three temporary openings 14 ft in diameter were formed in the lower part of the dam to care for the river during the second stage. The river was diverted from the temporary flume to the three temporary outlets on March 8, 1941. The temporary flume was then removed, the foundation cleaned up, and the omitted block was raised in step with the remainder of the dam. Diversion from the temporary outlets to the permanent river outlets was made on October 20, 1941. The temporary outlets were then filled with concrete. No special difficulties were encountered in handling the river.

Concrete aggregates for the dam are obtained by the contractor from a natural deposit some three miles down river from the dam site. The land containing the deposit is owned by the Government but the development of the deposit, including processing, transportation, and all other work connected with it, is performed by the contractor as part of the construction contract. After processing, the material is transported by diesel-electric trains, over a railroad constructed by the contractor, to track hoppers near the base of the dam; thence it passes by belt conveyors to the mixing-plant storage bins. As a by-product at the aggregate plant, a small amount of gold is recovered from the sand. The net profits from this gold-mining venture are divided equally, according to contract, between the Government and the contractor.

The mixing plant, located on a bench at El. 482, consists of four 4-cu yd mixers discharging directly through a central cone into the 4-cu yd buckets of the concrete train. From the mixing plant the diesel-electric train hauls the 4-bucket load out onto the placing trestle, where the buckets are picked up by the placing rigs, consisting of two hammerhead and two whirley cranes working from the trestle. At the extreme ends of the dam and on parts of the spillway and river outlet basins, where the work is beyond the reach of the trestle rigs, placing is accomplished by two stiff-leg derricks.

The concrete placing trestle is approximately 2,400 ft long and its top is about 200 ft above the river and about 100 ft below the top of the dam. Topping out of the dam will be done by the revolving cranes working from the trestle deck. The trestle was built to its final height (El. 482) at the start, so as to provide a level track for the concrete trains from the mixing plant. Blockouts have been provided where the trestle columns leave the downstream face; these will be filled with concrete after the upper portion of the trestle is salvaged at the completion of the job.

Design and layout of the contractor's plant have been excellent, and together with exceptionally good job management, have resulted in rapid progress and favorable costs. The maximum concrete yardage placed in any one day amounted to 9,059 cu yd, and the maximum monthly total occurred in August 1941, when 228,769 cu yd were placed. M. H. Slocum is the general superintendent for the contractor. Department heads are E. L. Causey, field engineering; E. W. Simpson, carpenter work; J. V. DeVine, mechanical; Frank Backman, embedded materials; Stanley Bent, Jr., mixing plant; I. L. Doane, warehousing; A. Gieger, pumps and miscellaneous; P. O. Hayes, aggregate plant; J. McGowan, rigging; R. V. Moore, railroad; L. C. Nesbit, trestle; G. E. Smith, electrical; James Walker, drilling; James Yeomans, concrete placing; and P. F. Schwartz, office manager.

This is a rugged, sparsely settled country with few improvements except at the lower end of the reservoir area. There were no railroads or important highways to be moved. The reservoir area contains no merchantable timber. At the lower end the timber cover is very light, consisting principally of oak; at the upper end it is heavier, consisting of oak and pine. All trees and brush are being cleared by small contracts, the bidder having the option to salvage the wood. Approximately twenty-five of these small contracts have been let, largely to local people who would otherwise not have participated in the construction work. This arrangement has worked out very well both for the small contractors and for the Government.

The Friant Division is part of the Central Valley Project being built by the Bureau of Reclamation, of which John C. Page, M. Am. Soc. C.E., is commissioner and S. O. Harper, M. Am. Soc. C.E., chief engineer. The writer is construction engineer for the Friant Division. On Friant Dam, J. H. Warner is resident engineer; D. S. Walter, field engineer; O. I. Craft, in charge of all surveys; J. P. Jones, office engineer; C. T. Douglass, engineer in charge of concrete control; and G. H. Witte, chief clerk.

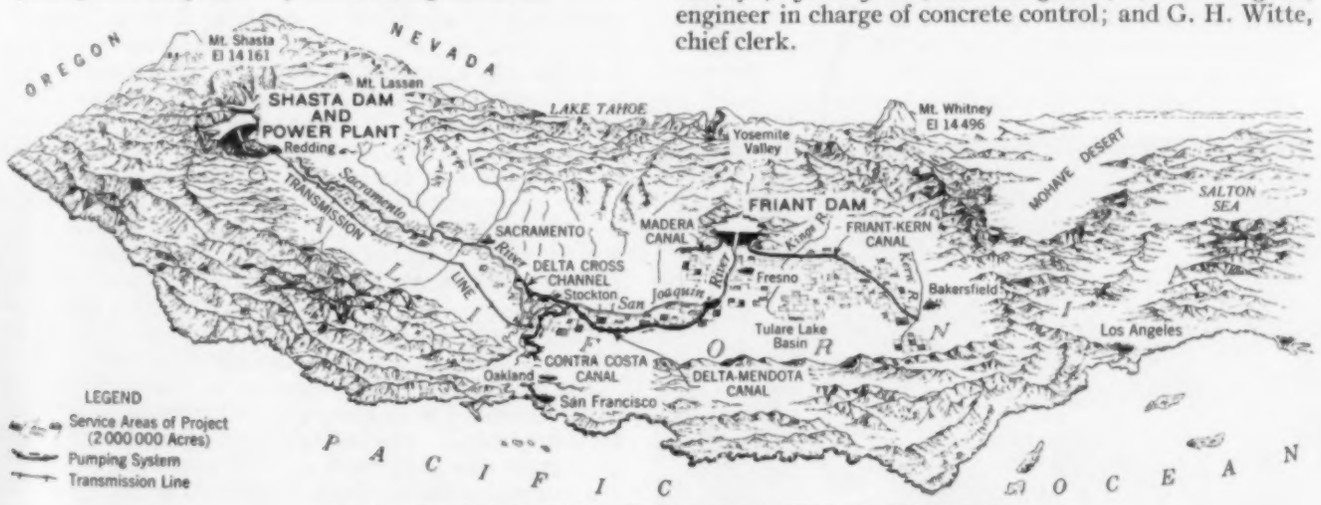


FIG. 1. FRIANT DAM IN RELATION TO THE CENTRAL VALLEY PROJECT

Soils Engineering Features of Washington National Airport Construction

By B. K. Hough, Jr., Assoc. M. Am. Soc. C.E.
Senior Engineer, U.S. Engineer Office, Binghampton, N.Y.

CONSIDERATIONS of economy and speed, combined with the proximity of suitable material, pointed to a hydraulic fill as the proper method of construction for the Washington National Airport. A careful soil testing and inspection program was of course necessary to produce the finished structure. Settlement, drainage, separation of desirable from undesirable material, bank protection, and control of waste material all had to be carefully correlated by the soils expert, as here explained by Mr. Hough.

At Gravelly Point on the Potomac River, the Washington National Airport has been laid out on an area of about 750 acres. Of this area, 500 acres were reclaimed from shoal river flats by hydraulic fill extending out from the shore line 2,000 to 4,000 ft. An outstanding feature was the special attention given to the selection and handling of the fill materials. This subject required intensive study because of the need for putting the field in service at the earliest possible date. The time that elapsed between the start of filling operations and the first landing of commercial planes on the field was approximately a year and a half. In this time about 20,000,000 cu yd of dredged fill was placed, over four miles of runways were constructed, about 1⅝ miles of the Mt. Vernon Highway was relocated, and the construction of terminal buildings, hangars, and other facilities was started. Approximately a half year later, on June 16, 1941, the field was opened for regular flying service. A paper on "Runways for the Washington National Airport," by E. L. Tarwater, Highway Engineer of the U.S. Public Roads Administration, appeared in the March 1941 issue of Civil Engineering.

Plans for the field, including the dimensions and relative positions of the runways, taxiways, aprons, and other similar features, were prepared under the direction of the Civil Aeronautics Authority. Details of these plans are given in Fig. 1. The PWA and WPA provided the funds, and the latter organization also furnished the common labor. The construction of the terminal building, hangars, and other structures was assigned to the procurement Division of the Treasury Department, now the Federal Works Agency. The Corps of Engineers planned and constructed the field with its drainage facilities. In conjunction with the Public Roads Administration it also planned and constructed the runway and apron pavements and relocated the Mt. Vernon Highway. This work of the Army Engineers, which is discussed here, included the soil testing and analysis done at the Engineer Department Soils Laboratory at Ithaca, N.Y., in the Binghamton (N.Y.) District.

The location of the field in relation to landmarks in the vicinity is shown in Fig. 2. Some previous operations of the Engineer Corps affected the work. One of these was the excavation off Hunters Point for fill for the construction of the Mt. Vernon Highway about 1929, which resulted in forming a fairly extensive basin some 20 to 30 ft in depth near the intersection of the proposed north-south and northeast-southwest runways. This basin had shoaled to a depth of from 12 to 15 ft with fresh unconsolidated deposits of river silt. In addition to this, filling had been conducted at the intersection of the northwest-southeast and northeast-southwest runways, where about 1,750,000 cu yd of river silt and sand was deposited from 1927 to 1937 in disposing of material from dredging operations incident to channel maintenance in the river. This fill, being above water, had seasoned considerably and formed an island of relatively firm material. Information obtained during these operations by Government forces and in connection with dredging by sand and gravel contractors at Gravelly Point, indicated that a relatively shallow deposit of soft river silt from 5 to 30 ft deep covered the area generally, except as noted, but that below this there were fairly extensive beds of sand and gravel.

The decision to construct the field by hydraulic fill was based on several considerations, economy being an important one. Another important advantage was that the dredging beyond the limits of the field to obtain fill material would deepen the river channel and thus compensate for the constriction of the floodway resulting from filling at the site. These two factors alone would not have been sufficient to justify the hydraulic method, however, without some assurance that a firm, stable fill could be produced to meet the requirement of early utilization of the airfield. This assurance was provided in the basic plan of construction which called for building the runways as independent fills with selected coarse-grained materials, the secondary or intermediate areas to be filled in with the more compressible river silt, which had to be handled in obtaining the select material. An alternative to this plan—that is, wasting all the silty material and constructing the field throughout of sand and gravel—would have involved pumping an additional 12,500,000 cu yd at an added expense of over $2,000,000 and would have caused shoaling in the river that would not have been permitted.

For the construction of the runway fills, the design provided not only for filling with sand and gravel but also for the removal of as much of the existing river silt as possible before the fills were started. It also called for the construction of the field to an elevation above the finished grade in order to offset anticipated settlements. This was decided upon in preference to subsequent filling in connection with field maintenance. The finished grade was established with reference to hydraulic and hydrologic conditions. For the field itself, the adopted grades gave assurance of protection in the event of a flood with stages equal to the highest recorded (1936) and the record tide (1933). As for the buildings, protection has been

Air View of Gravelly Point During Construction Period Shows Levees Outlining Entire Area of Field

provided against a computed super-flood exceeding the worst conditions of record.

During the fall of 1938, trenching for runways was started and construction of the bounding levee along the upstream limits of the field was begun. At the same time subsurface investigations were conducted in areas proposed for both fill and borrow. Borings or probings at intervals of 250 ft on centers both ways were completed in a period of scarcely more than a month over an area approximately 9,000 by 4,000 ft. Of the many soil samples taken during the explorations, about 1,000 were transported to the Ithaca Laboratory for examination. Samples from the fill areas were tested with the objective of determining the compressibility and shearing strength of the foundation materials. Samples from areas where dredging was to be conducted were subjected to mechanical analysis to establish the variation in types of material. The exploration and initial testing program showed that in some of the fill areas, trenching for runways would not be feasible, as originally planned, in view of excessive depths of mud. Therefore runways were trenched only where feasible. This created a situation which might have caused differential settlement of runways; to offset this possibility, plans were made to raise construction grades in untrenched areas to accelerate consolidation of foundation materials locally prior to final grading.

In establishing the limits of borrow areas and estimating quantities of different types of fill materials, the division between select and secondary grade materials was set as the grain size used to distinguish between sand and silt, that is, at 0.06 mm, or (approximately) the size of the largest particles passing a 200-mesh sieve. Excavation of borrow material for select fills was accomplished in general without preliminary stripping of the overlying second-class material by sinking the cutter head of the dredge into the underlying sand and gravel and taking everything that came into the suction pipe. Since the yield of select material was somewhat larger than anticipated, it is assumed that some of the sand content of the silt (indicated by test to be from 10 to 15%) was separated and retained in the select fills.

The initial filling operation, that for runway construction, was started in the early spring of 1939, when commercial dredges were placed under contract and transferred to the site. The dredges *Gulfstream*, *Pennsylvania*, and *Ellendale*, with 27 and 28-in. discharge pipes, were employed on this work as well as the 18-in. Government dredge *Talcott*. During one stage of runway construction, before ponding in the fill area was accomplished, runway fills were confined by longitudinal dikes to prevent wastage of select material. Two dikes parallel to the runway center line were thrown up along the waterline for this purpose and spaced as far apart as the proposed width of the runway. All the elements of earth-fill dam design and construction were involved on a small scale in building these retaining levees. Foundation stability, for example, was an extremely pressing consideration since the steep-sided levees were constructed on a relatively thin sand blanket overlying the original soft mud bottom. In several locations incipient foundation failure was indicated by raising of the ground surface at the levee toe in the familiar "mud-wave" formation. Two controlling factors in this problem were the depth of soft foundation material and the thickness of the sand base course. A stability analysis was made as a guide for levee construction, and the combination of conditions likely to cause

RUNWAY GRADING AND COMPACTING WAS ACCOMPLISHED WITH BLADE GRADERS AND RUBBER-TIRED ROLLERS

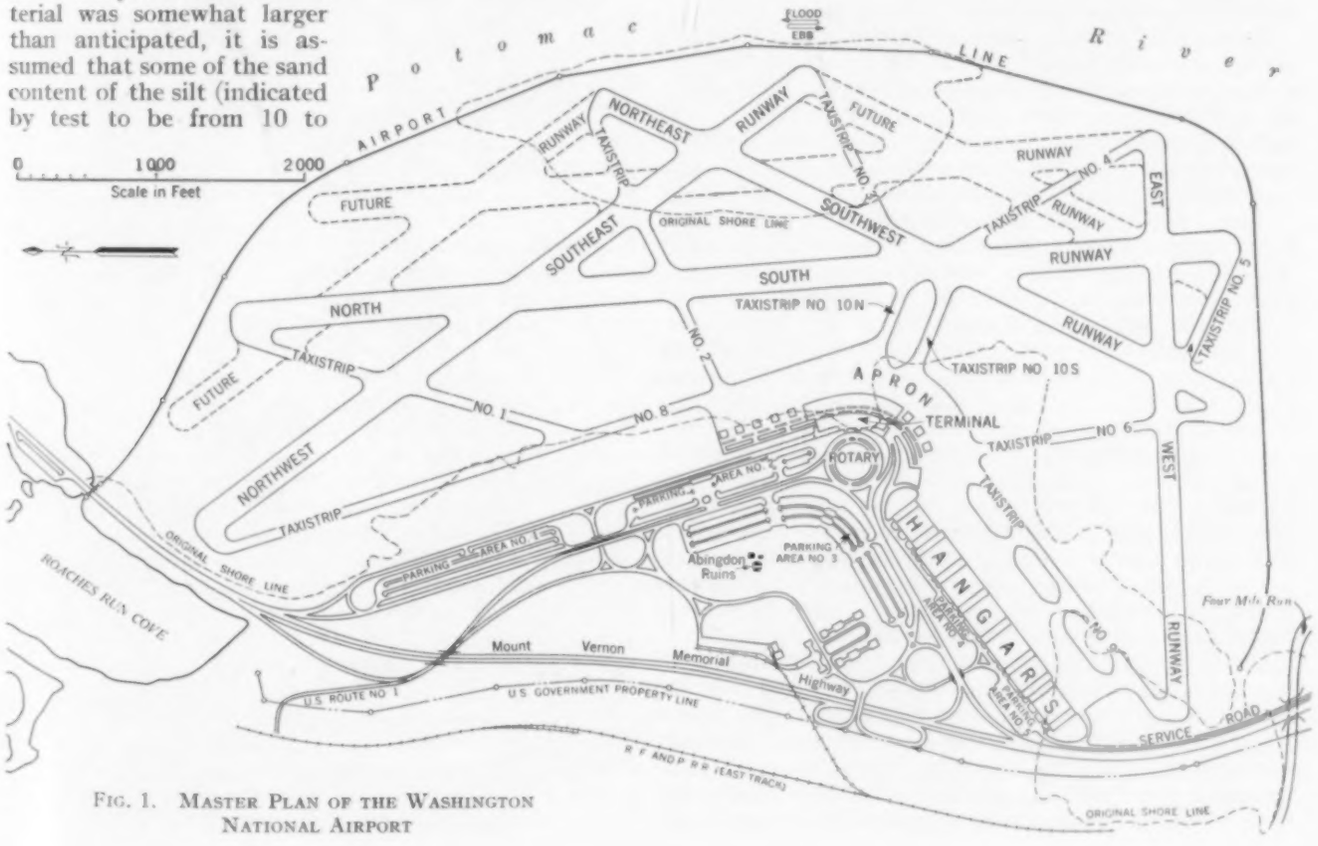


FIG. 1. MASTER PLAN OF THE WASHINGTON NATIONAL AIRPORT

INCIPIENT FOUNDATION FAILURE WAS INDICATED BY RISING OF THE GROUND SURFACE AT THE LEVEE TOE IN THE FAMILIAR "MUD WAVE" FORMATION

failure and the combination required for stability were determined. From this investigation it was demonstrated that levee stability increased as the thickness of the sand base layer increased, but decreased as the depth of the underlying clay increased. The curves in Fig. 3 translated this general conclusion into specific information applicable to the varying field conditions.

While the runways were being constructed, the ring levee around the periphery of the field was in progress. Since this levee was to enclose the field and thus facilitate filling to final grade, and was also to form the outer, exposed edge of the fill, it was constructed for the most part of select material like the runways. On the north and south ends of the field, the levee was raised to the elevation for final grading by hydraulic filling in part by the "bleeding" method, after which a temporary levee was thrown up by crane to permit ponding to the higher elevations required for gross working grades. On the east, a considerable amount of fill was already in place as the result of spoil dumping from previous dredging for channel maintenance. This existing fill was utilized as the east levee base course and was merely topped by a temporary construction levee.

During final grading, these temporary levees were cut down to form the face of the airport fill. As a result of studies made at the Ithaca laboratory, the north levee fill, for which excellent material was available, was baffled to produce slopes as steep as possible and thus conserve select material. The south levee, however, was constructed with free-flowing discharge and consequently on flatter slopes. Foundation stability there was more of a problem because of the greater depth of compressible silt. The levee system in general was designed not only to secure foundation stability but also to resist the lateral pressure of the ponded fill material.

It was planned to protect the outer face of the levee by sodding and by a narrow zone of revetment at the water's edge. The revetment was originally intended to protect against wave wash, but after installation it was found that it also stabilized the slope against the outflow of ponded water from the fill. In this connection it should be stated that all the coarse-grained pervious runway fills were extended to full junction with the bounding levee so that water entering the runways from the sides or bottom could seep out through the ends. This procedure is credited with expediting to some extent the consolidation of foundation and pocket material.

When the field was completely enclosed by the bounding levee, placement of material in the intermediate pocket areas between runway fills became the major construction item. Since this material was extremely compressible when first deposited, the problem of determining a gross working grade sufficient to compensate for eventual shrinkage and subsidence was of considerable importance. Theoretical analysis of this problem was complicated by the following circumstances. The magnitude and rate of settlement of an earth fill depend upon the effective weight of the material and its consolidation characteristics. In the case of material deposited in water, the weight depends on the position of the ground-water table. In clay-type material this is very difficult to determine.

Consolidation characteristics must be found by tests on representative soil samples. In this case, the nature of the pocket fills could not very well be determined in advance because of doubt as to the amount of sand sizes that would work out of the river silt in the borrow areas. Neither could the pockets be sampled satisfactorily during construction. For these reasons, initial estimates of fill subsidence were based entirely on experience with fills of a similar nature in other local work. Theoretical soil analysis, which had been found useful in connection with other features of the job, was not attempted. Ultimate subsidence, the factor that established the working grades, was estimated to be 25 to 30% of the depth of the compressible material.

Filling in the Four Mile Run area, to form a base for relocating the Mt. Vernon Memorial Highway, was one of the last operations performed by dredging. As may be seen from Fig. 1, at the mouth of the Run there was a fairly large pool, formed in part by the fill for the existing highway. Construction records on this old fill showed that considerable difficulty was experienced with excessive subsidence as the fill was extended from firm ground across the deposits of silt and muck formed by sedimentation from the creek discharge. Exploration by probing showed that in the pool itself, inside the highway fill, firm bottom was much deeper than under the old fill, and in fact in some places was 35 ft down.

Under these conditions, deliberate or accidental rupture or displacement of bottom material with

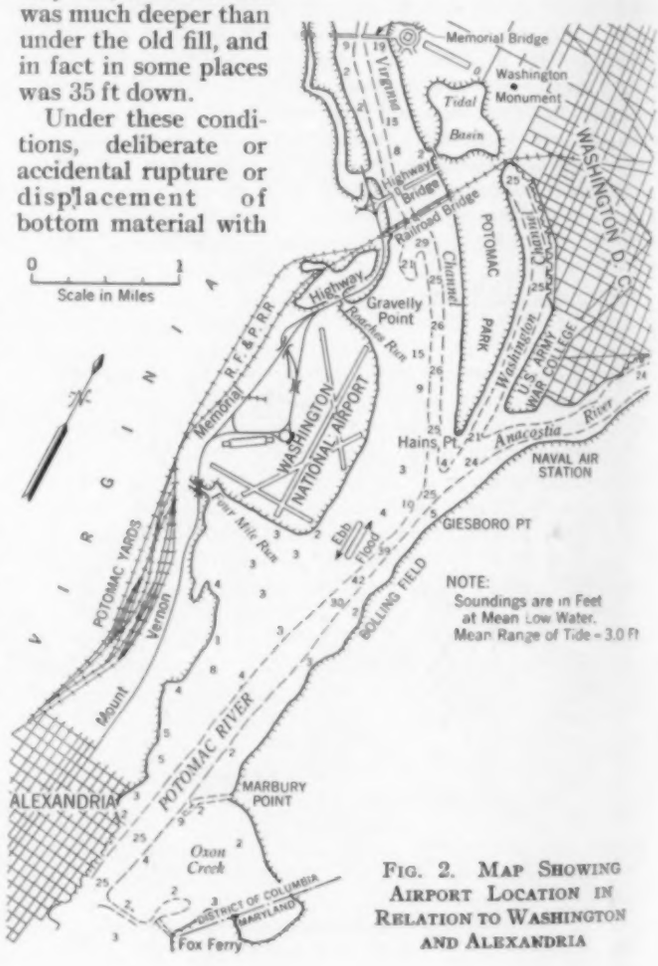


FIG. 2. MAP SHOWING AIRPORT LOCATION IN RELATION TO WASHINGTON AND ALEXANDRIA

the new fill for the highway relocation might have led to unjustifiable expense for excessive amounts of fill material. Provision was therefore made for blanketing the muck and bringing the fill up in layers. The first step was to pump in an extensive layer of fine sand, this material being chosen instead of coarse sand and gravel since it was found that the latter material tended to penetrate rather than blanket the muck. Hydraulic filling was terminated when the sand base course was raised to an elevation slightly above the water level. Subsequent filling was accomplished by dry-fill methods with an impervious silty clay obtained from adjacent upland areas.

A layover period of about seven months between the hydraulic and the dry filling was made possible by the sequence of construction operations. This is believed to have afforded time for the muck to consolidate somewhat under the blanket fill and to be in better condition to receive the second stage of fill placement. In any case, little difficulty was experienced with the dry fill, and pavement was laid and the road opened to traffic within about two months from the time the dry fill was begun. There was some inevitable subsidence of the fill, but this was due to consolidation, not rupture, of the foundation material. The rate of subsidence, which was indicated by a series of settlement plates, was such as to give assurance that a substantial part of the ultimate settlement occurred during construction.

Because of the unusual character of the fill, the problem of disposing of surface runoff called for consideration of a number of very different plans. As has been stated, the field included the relatively pervious sand and gravel runway fills cutting through the impervious pocket fills and intersecting each other and the bounding levee at numerous points. From the standpoint of drainage, these pervious fills could be regarded as a large-scale system of French drains with provision for free discharge at their outer ends—although the extent to which longitudinal flow might be blocked by the existence of slightly inclined clay films formed during different stages of construction on the advancing face of the runway fills required consideration. It was also recognized that the coarse-grained fills had a large potential capacity for temporary storage of rain water in the void spaces between ground-water level and the surface of the runways even though no appreciable outflow at the ends occurred during the period of inflow.

In view of these special conditions, some consideration was given at first to grading the field and designing the pipe drains so as to conduct water to the pervious fills, and in one way or another utilize their natural capacity for storage and discharge to reduce the size and amount of drains required to handle storm runoff.

One plan considered for accomplishing this purpose was to construct a strip 25 ft wide along each side of the runway pavements, with a porous but stable surface formed with gravel tacked together with a light coating of asphalt, and beneath this surface treatment to install a French drain containing a porous or open-jointed pipe leading to outfalls. Grading of adjacent areas would be designed to cause flow toward this drainage strip. A vital factor in this plan was the rate at which water could be expected to enter the voids in the pervious fill after being introduced through the surface drain, and the rate at which seepage through the fill and outflow at the ends of the runways to the river would take place.

Both field and laboratory tests were made to obtain data on the permeability of the runway fill and rate of infiltration. The advantage claimed for the laboratory tests was the ability to secure more complete control

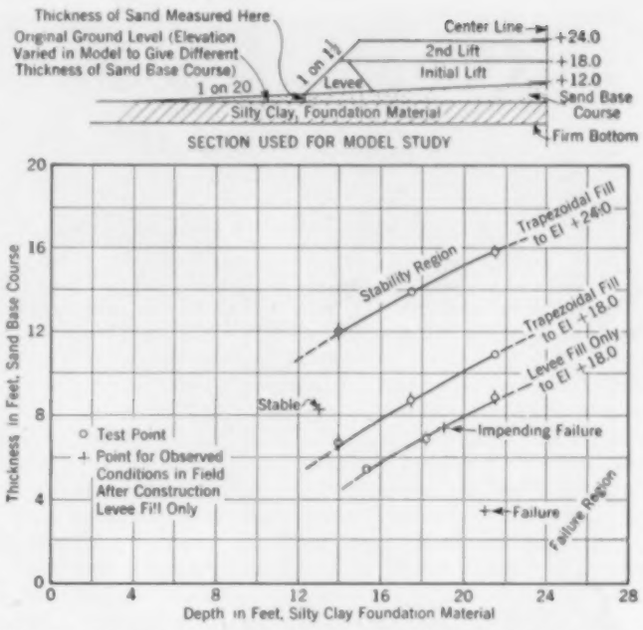


FIG. 3. STABILITY ANALYSIS PLOTTED FOR LEVEE CONSTRUCTION

over such variables as cross-sectional area of flow and path of percolation. Since the runway fill consisted of material ranging from 200-mesh sand to 6 or 8-in. stones, the laboratory tests for permeability were conducted on "samples" weighing approximately one ton, using a permeameter 4 ft square. With this large equipment it was unnecessary to remove any of the stones and it was possible to test completely representative samples in a range of densities bracketing the density of the material in nature. At the same time field tests were conducted on the runways themselves using a sprinkler installation over representative areas.

Field and laboratory tests did not check satisfactorily, the latter indicating that water could be absorbed by the fill nearly ten times as fast as the former. Investigation of this discrepancy led to the conclusion that the laboratory results, in spite of the special equipment used, were inapplicable because no provision had been made for simulating the condition of airblocking which existed in the field in the surface material above ground water. Laboratory testing procedure and equipment in this case had been designed for fully submerged materials as in dam foundations, and it was conceded that airblocking of non-saturated surface materials could affect the results. From these studies, the ability of the runway fills to receive water as fast as necessary to dispose of surface runoff was concluded to be unreliable if not actually inadequate. A completely closed pipe system was therefore planned.

Before the runways were paved, the sand and gravel subgrade was stabilized by the addition of a clay soil binder from the upland area. Twelve inches of loose material was compacted after blending with fines to a depth of 9 in. and a minimum density of 130 lb per cu ft. When thus compacted, the subgrade was found to have a bearing value generally in excess of 85 lb per sq in.

The work here described was executed by the U.S. Engineer Office, Washington, D.C., with the late Col. R. S. Thomas, M. Am. Soc. C.E., as District Engineer. The following personnel was in charge of operations during the construction of the field: Lt. Col. J. B. Newman, and Senior Engineer E. J. Merrick, Jr., in charge of engineering; Gayle McFadden, Chief of the Operations Division; and B. J. Bell, in charge of paving the runways.

Concrete Production and Control for Saugatuck Dam

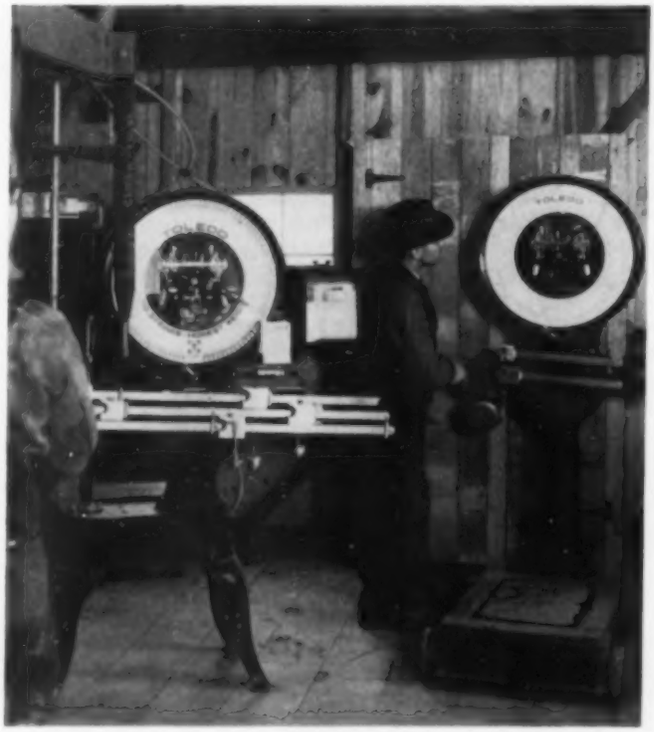
By W. R. Miller

Chief Engineer, Scientific Concrete Service Corporation, Washington, D.C.

CONTROLLING the water content of concrete mixes has always been a problem on both large and small projects. The designing engineer, thinking of strength, wants the mix as dry as possible; the field construction engineer, confronting the problem of placing, often wants it wetter and more workable; the foreman, who does not understand the problem, invariably demands more water. These conflicting viewpoints make it necessary to have quick, accurate, and economical control of moisture content. Inaccurate control quickly makes itself felt in terms of loss of strength and consequent high cost for an inferior product. In this paper, Mr. Miller describes an accurate control method for concrete mixing, which because of its low cost is applicable to the smallest as well as the largest project.

SAUGATUCK DAM, now nearing completion on the Saugatuck River, about 12 miles northwest of Bridgeport, Conn., includes many construction features of interest to the engineering profession. This applies particularly to the methods used for obtaining accurate control of the concrete mixes, as such control, while common on large dams, is usually considered too expensive for projects as small as this.

The dam is being constructed by the Bridgeport Hydraulic Company, to furnish additional storage capacity to assist in supplying the rapidly increasing water requirements of the Bridgeport industrial area, which is of great importance to the national defense effort. The reservoir formed by the Saugatuck Dam and a subsidiary dam will furnish water for the city of Bridgeport and the towns of Fairfield and Westport. It will have a storage capacity of 12 billion gallons, will cover 870 acres, and be supplied by a watershed of 32 sq miles. The project includes, besides the main dam, a smaller dam or dike, and two concrete-lined tunnels.



Meter Scale Automatically Shows Water Content of Aggregate Sample of Known Specific Gravity

Sample Is Weighed First at Bank Moisture, Then Saturated

The main dam is 1,000 ft long at the top, 125 ft high, and 100 ft thick at the base. It is a gravity-type structure containing approximately 80,000 cu yd of concrete with a spillway elevation 280 ft above sea level. The smaller dam, also a gravity structure, is 650 ft long and has a maximum height of 42 ft. It contains 5,600 cu yd of concrete and closes a gap in Popps Mountain which would otherwise act as a spillway.

The two concrete-lined tunnels, each finished to a diameter of 6 ft 4 in., will carry water under the mountains between the Saugatuck Reservoir and the Hemlocks Reservoir, which is part of the existing water supply system. Popps Mountain Tunnel is 1,270 ft long, and Flirt Mountain Tunnel is 5,900 ft long. A total of 2,400 ft of cement-lined cast-iron pipe, 48 in. in diameter, connects these tunnels with the Saugatuck and Hemlocks reservoirs.

Aggregate used in the concrete comes from a glacial deposit located about three miles upstream from the dam. Here, after passing through a 12-in. bar grizzly, the material is fed through a revolving bull screen (which takes out cobbles over 6 in. in size), and thence to a conveyor belt. The oversize material is run through a jaw crusher before reaching the belt. The conveyor feeds the washing plant, where the aggregate is passed through a scrubber section before entering rotary screens, where final washing and grading take place. These screens separate the material into sand and three sizes of coarse aggregate as follows: pea, $^1/_4$ to $1^1/_4$ in.; medium, $1^1/_4$ to $2^1/_2$ in.; and cobbles, $2^1/_2$ to 6 in. The fine aggregate consists of one size of sand having an average fineness modulus of 3.00.

Stock piles of each size of aggregate were maintained to insure against interruptions due to a breakdown at the washing plant, but ordinarily the coarse aggregate was loaded directly from the washing plant bins into trucks for delivery to the concrete plant.

Stock piling to regulate the moisture content of the aggregates has not been found necessary on this job because of the concrete control method, which will be described later. By eliminating this extra handling, segregation and breaking of coarse aggregates were materially reduced. Sand was handled in the same way as the coarse aggregate except that, instead of being stored in bins, it was run directly to stock piles from which it was loaded into trucks by gasoline shovels.

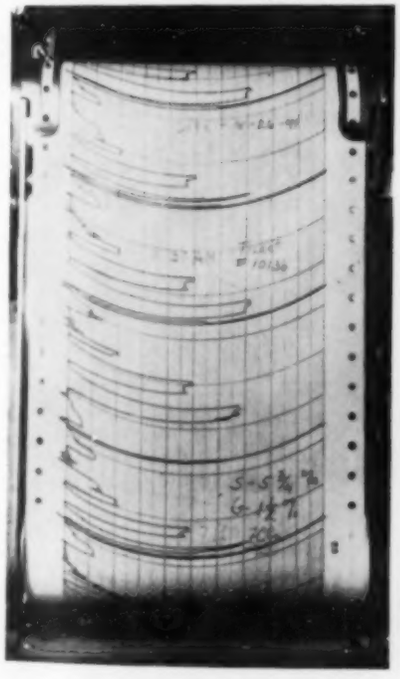
The concrete plant is located near the west end of the dam and consists of a 390-ton steel bin with four aggregate compartments and a 500-bbl cement compartment. Bulk cement is loaded through an enclosed bucket elevator, and aggregates reach the top by means of a conveyor belt. The batching floor of the bin contains the

cement, water, and aggregate batching equipment, the moisture determination equipment, and the controls for operating the concrete mixer. It is here that the moisture content of the aggregates is determined and compensation made for variations. The method of doing this merits particular attention as it is one of the outstanding features of this operation.

Accurate and practically automatic compensation for the moisture carried by each size of aggregate is provided by means of specially designed scales. At frequent intervals, at least four times every hour although at times from every batch, samples of the sand and coarse aggregate are tested for moisture by means of the moisture meter scale which, without calculation, determines the percentage of free moisture to within one-fourth of 1%. A moisture test requires less than one minute and is usually made by a technician, but is so simple that in emergencies it can be made by one of the weighmen.

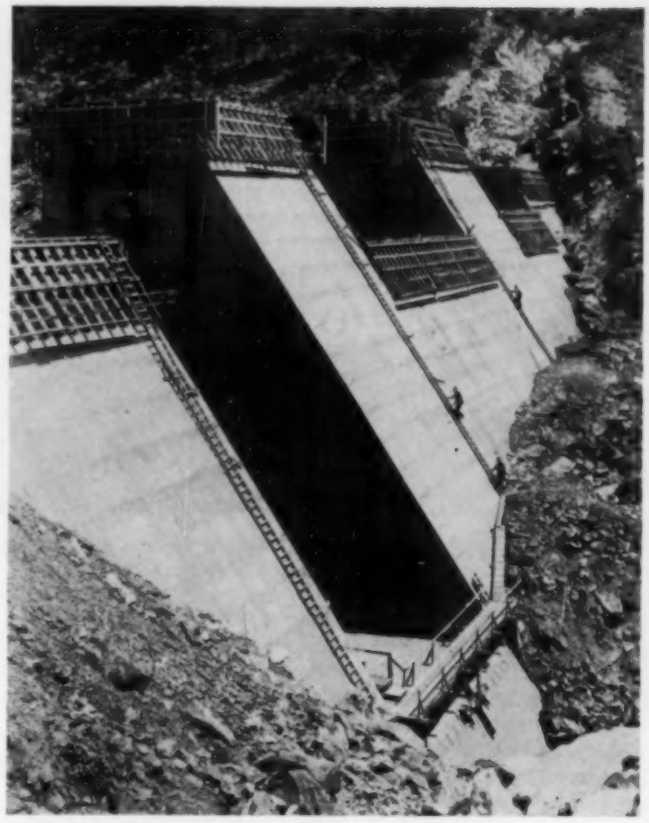
Compensation for the moisture is made automatically on the batching scale, which is a full dial scale having a separate beam and poise for each ingredient, including water. Each aggregate that carries free moisture is assigned to a special scale beam equipped with a compensating-type poise so designed that by adding small disks, calibrated in per cent, its weight can be increased by any desired percentage. Thus when a poise is set to the weight of dry material required, and disks totaling the percentage of surface moisture carried by the material are added, the dry weight plus the weight of the contained moisture will be shown on the dial. The proper bin gate is then opened, and as the material enters the weight hopper the scale indicator moves backward until it reaches zero, when the correct amount will have been weighed out.

After each aggregate has been weighed in this manner, the poise assigned to water is set at the total weight of water required for the batch, and the percentage disks previously added are removed. This automatically deducts the amount of water carried by the aggregates from the total required for the batch, leaving only the net amount to be added, which will show on the scale dial. The water is weighed into a separate compartment of the weigh hopper through a solenoid-operated valve controlled by a mercury-magnetic switch. The latter causes it to close automatically when the scale pointer reaches zero, thus insuring that the correct amount has been weighed out.



AUTOMATIC METER RECORDS TIME OF MIX AND WEIGHT OF EACH INGREDIENT IN THE BATCH

By this method the total water in each batch is held to a tolerance of around 1 gal per cu yd, which insures unusually close control of the water-cement ratio. A graphic recorder attached to the scale head makes a permanent record of every movement of the scale and shows the weight of each ingredient and the compensation made for moisture carried by each aggregate.



SAUGATUCK DAM WAS POURED IN MONOLITHS 4 FT HIGH BY 40 FT WIDE AND AS THICK AS THE DAM ITSELF

Concrete is weighed out in 2-cu yd batches and mixed in a 2-cu yd tilting mixer directly under the batching floor. From the mixer it is dropped into bottom-dump buckets holding two batches, or 4 cu yd each. These are carried on a flat car approximately 50 ft to a position under the cableway, where they are picked up and taken to the place of deposit. The concrete is placed in blocks averaging 4 ft high by 40 ft long, extending the entire width of the dam. It is compacted by pneumatic internal vibrators.

The concrete mixes used are noteworthy, having been designed by Duff A. Abrams, M. Am. Soc. C.E., to produce a very dense mix with a low water-cement ratio and a low water content. Aggregate up to 6 in. in size is used with approximately 29% sand. The optimum grading was determined at the start of the job, and adjustments of the proportions of each size to compensate for variations in grading and overrun are made frequently. For these reasons and because the equipment is capable of handling a very stiff concrete, having a slump of about $^1/_2$ in., the water requirements per cubic yard are extremely low. Volume change in the concrete is kept at a minimum by using medium-heat cement (Federal Specification No. S.S.-C-206) and a low cement factor, while strength is assured by using a stiff mix having a low water-cement ratio.

For exposed faces, a mix having a cement content of 1.06 bbl per cu yd with a water-cement ratio of 0.54 by weight produces concrete having an average compressive strength of 4,200 lb per sq in. at 28 days. The core or mass concrete, with a cement content of 0.93 bbl per cu yd and a water-cement ratio of 0.61, produces an

POURING IS ACCOMPLISHED BY TRAVELING CABLEWAY WITH 4-YD BOTTOM-DUMP BUCKETS

average strength of 3,600 lb per sq in. at 28 days. Compression tests of samples cured for one year in damp sand at room temperatures showed average unit strengths of 5,710 lb for face concrete and 4,920 lb for mass concrete.

The cement used on this project was furnished by the Vulcanite Portland Cement Company and tested by the Pittsburgh Testing Laboratories. All control tests of aggregate and concrete were made by the Scientific Concrete Service Corporation at their laboratory on the job.

Concrete for Popps Mountain dike was transported from the mixer to the dike, a distance of about one mile, in bottom-dump buckets holding 2 cu yd. Trucks carried these to the site, where a stiff-leg derrick with a 60-ft boom moved them to the place of deposit.

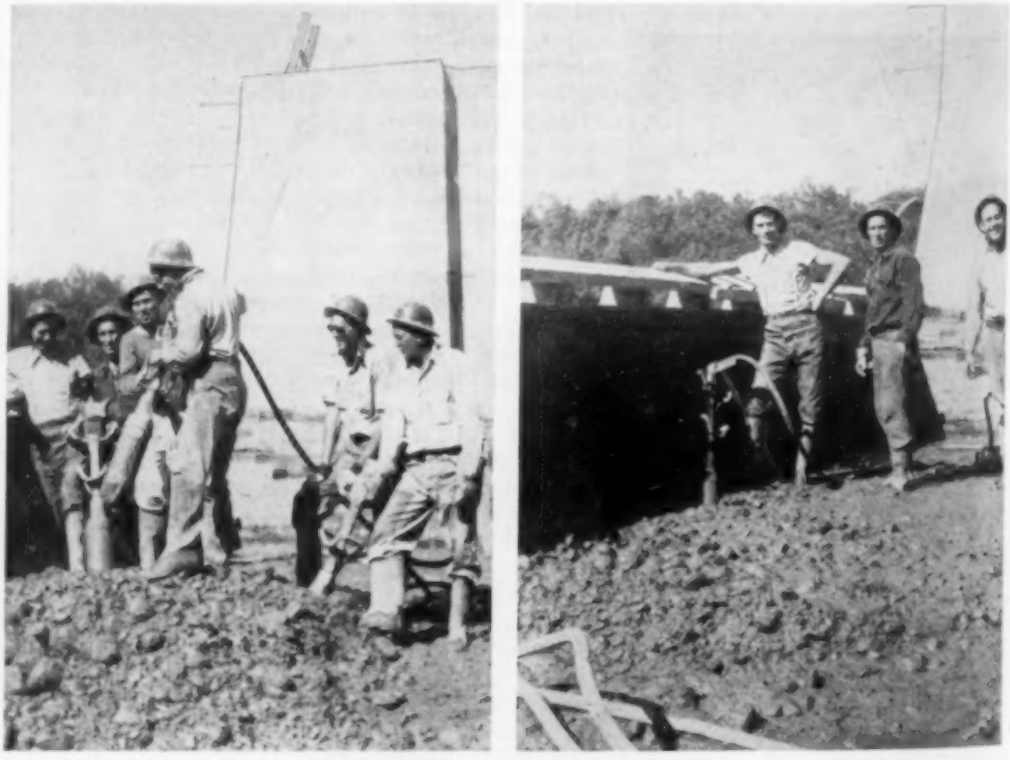
For lining the two tunnels, a 110-ton bin was erected over the mouth of the longer tunnel. A ramp permitted charging the bin directly from dump trucks. This bin fed a 1-cu yd mixer. The equipment for weighing, moisture determination, and moisture compensation was similar to that used at the dam except that it was designed for smaller batches. Only sand and one size of coarse aggregate were used, this being the pea size ($^1/_4$ to $1^1/_4$ in.), produced at the washing plant.

From the mixer the concrete was run into trains of bottom-dump hopper cars holding 1 cu yd each, which were pushed to the place of deposit in the tunnel by electric locomotives. By an ingenious arrangement, the hopper cars discharged directly onto a conveyor belt, which fed a $^1/_2$-cu yd pneumatic concrete placer. This forced the concrete through a 6-in. pipe into the opening between the steel lining forms and the rock tunnel walls. A 2-in. slump was sufficient for the invert section, but the arch section required a slump of about 4 in. The water-cement ratio for both the invert and the arch mixes was 0.56 by weight, and a compressive strength in excess of 4,000 lb per sq in. at 28 days was obtained.

The auxiliary dam and the two concrete-lined tunnels were already completed, and the main dam was 98% completed when severe weather set in. Weather permitting, it is expected that the remaining pours will be made some time in February, although filling of the reservoir was started on January 15.

It is unusual for a private utility to undertake a project of this magnitude and handle the entire job as is being done in this case. Although this is the largest project ever undertaken by the Bridgeport Hydraulic Company, it is not the first. The company built the Hemlocks Dam in 1914, and the Easton Dam in 1926, in addition to a number of smaller ones.

The Saugatuck Dam was designed by Clarence M. Blair, Inc., consulting engineers, of New Haven, Conn. Samuel P. Senior, M. Am. Soc. C.E., is president and chief engineer for the Bridgeport Hydraulic Company. W. C. Pollett is engineer in charge, and W. C. Merrill is superintendent of all construction. Duff A. Abrams, M. Am. Soc. C.E., was consulting engineer on concrete, and W. O. Wiggens on foundations. The Scientific Concrete Service Corporation, of Washington, D.C., supplied the specialized equipment for concrete control, with the writer in charge. The corporation's two technicians, who made the routine tests for maintaining the concrete control, were Harry Woosnam and Frank Curtis.

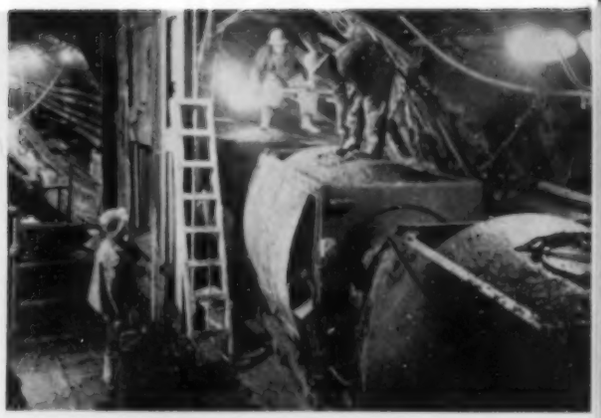


CONCRETE OF LESS THAN ONE-INCH SLUMP BEFORE AND AFTER VIBRATING

The Engineer in the Contracting Industry

Problems Must Be Recognized as Opportunities for Greater Service

By ADOLPH J. ACKERMAN, M. AM. SOC. C.E.
DIRECTOR OF ENGINEERING, DRAVO CORPORATION, PITTSBURGH, PA.



MEN AND MACHINES WORK TOGETHER IN TRANSPORTING CONCRETE FOR A TUNNEL LINING

PROFESSIONAL civil engineering presents many different fields from which the student engineer may choose his life work. Many of these fields are related to the construction industry. One engineer designs engineering structures, another supervises the actual construction, another is the builder who contracts to fabricate the finished structure, and others specialize in equipment, economics, labor relations, or administration. Most of us at one time or another do a little of a number of these things. For the student engineer choosing a major field for specialization, Mr. Ackerman, member of the executive committee of the Society's Construction Division, discusses the related, interdependent, and often conflicting phases of this important field. For the engineer in any way connected with the construction industry, he suggests actual instances where cooperation and mutual understanding would be beneficial to all.

IN order to plan an adequate program of training for engineers in the construction industry, it is necessary first of all to have a clear conception of what the construction industry is, how it functions, and what its basic problems are. A suggested source of information is the article, "The Case for Construction," in *Nation's Business*, the official publication of the Chamber of Commerce of the United States (April 1941).

Second, it is necessary to establish clearly the difference between the work of the engineer in the contracting field and the engineer supervising contract construction work, because the type of training required for the two fields is quite different. A significant statement on this subject appeared editorially in *Engineering News-Record* (November 24, 1938) under the heading "Arbiter or Advocate." A good statement of the difference between the engineer and the contractor is the following: The engineer determines what to build; the contractor determines how to build. Thus the contractor's point of view on a project may be quite different from the engineer's. The more freedom the contractor has, the more ingenuity he can display, with consequent greater advance in construction progress as well as in engineering and general public benefits. Unfortunately in many cases the contributions of contractors in such matters as sinking deep piers or building shipways, superhighways, large dams, or long tunnels are obscured. It is not uncommon to find that the contractor who constructed a project, and who devised many ingenious methods to overcome obstacles of floods and other hazards, is not even mentioned in publications describing the work, and only seldom participates in the dedication ceremonies.

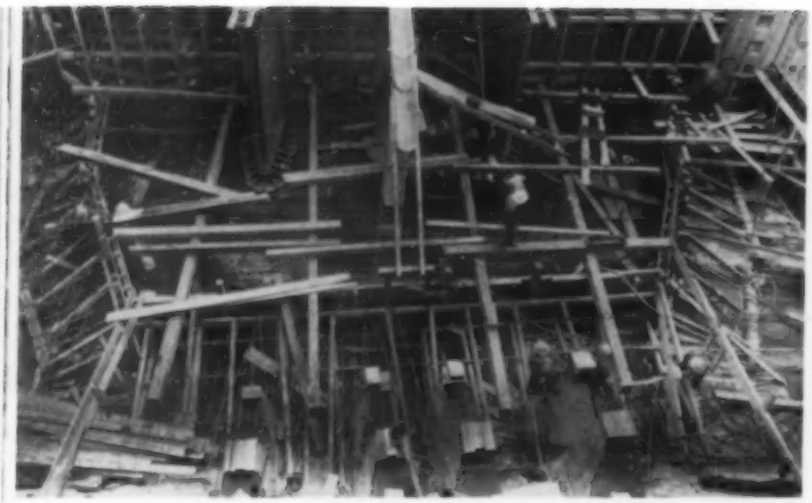
Contractors have a wealth of practical experience and vision as a background for the execution of prospective work, which is all too often overlooked by engineers in preparing new plans and specifications. As a result, such designs are often based on out-dated methods of the past rather than on progressive methods of the future. Where engineers have recognized the value of collaboration with the contractor in planning new projects, a higher level of attainment has been reached by both sides.

For engineers it is important to understand the contractor's problems and procedures. Some engineers occasionally expect the contractor to do more than the specifications require or to cover up deficiencies by putting into the job things not called for in the contract. With a better understanding on the part of both parties, a greater intellectual honesty could readily be developed, so that the best interests of the job would be placed above selfish advantage or personal jealousy. This approach needs much cultivation and training on both sides.

For better cooperation the engineer must understand the basis of the contractor's estimate. Many engineers think the contractor carries around a little book with a set of unit costs in it, and that when the contractor sees a tabulation of quantities of work to be done, all he needs to do is to apply those unit costs and figure the bid. Nothing is further from the truth. The preparation of an estimate requires the actual construction of the job on paper, step by step, with every important detail anticipated, with every piece of machinery and its productive rate established, with all the crews of labor and skilled personnel defined, and with all of the overhead, clerical, and supervisory services scheduled in detail. It is only by making an estimate on such a basis and then dividing the cost of each operation by the quantities of work to be performed, that the unit costs are established. And of course the details which make up such costs are different for every locality and for every job. With the cost estimate thus established, the contractor evaluates his overhead expenses, taxes, and risk, plus compensating profit, and thereby establishes his bid price.

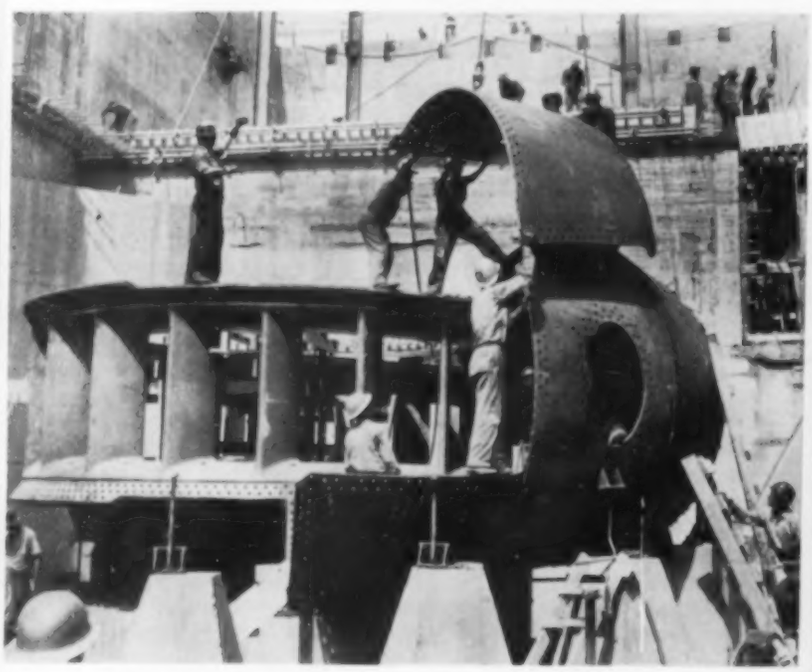
Many engineers tend to overlook the financial obligations which a contractor assumes. If a contractor takes chances he should be paid for them; and furthermore, if he is obliged to guarantee the work and to guarantee certain results, this should be clearly recognized as deserving of extra compensation. It is up to the engineer to protect the contractor from unwarranted demands. According to statistics, only about 15% of contractors survive over a long period of time. Much of this of course is their own fault, but engineers can help to protect the construction industry in so far as it serves the public interest.

On the other side is the fact that the construction industry has been notoriously lax in developing for itself a better representation as an industry, both before the public and before those with whom it deals directly. M. W. Watson, president of the Associated General Contractors of America, recently stated, "An expanded public relations program is highly necessary if our industry is to survive and hold anything like its present market, particularly in the public works field." Not long ago a

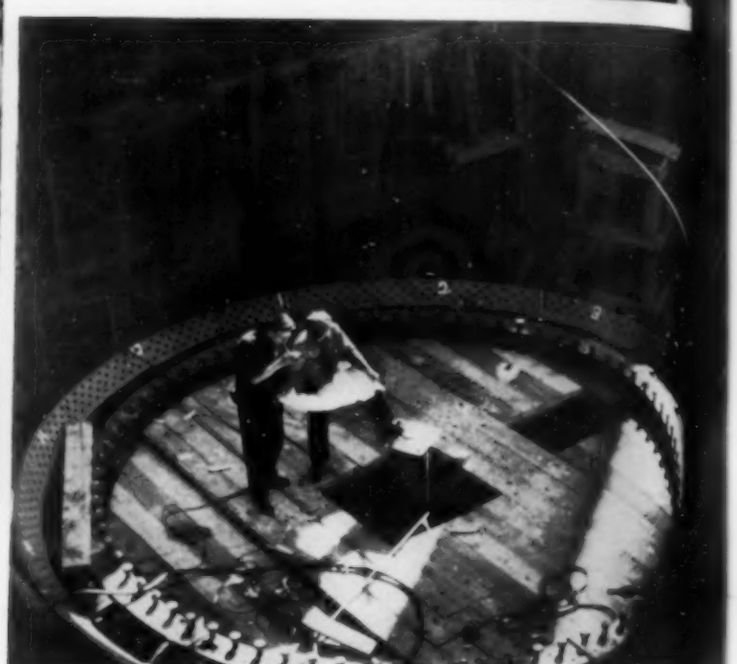


Form Work at Entrance to Draft Tubes
Heavy Construction of This Type Demands Expert Knowledge of Specialized Subjects

Assembling Apparatus for an Electric Generator
Learning How to Handle Labor Is an Essential Element of the Engineer's Preparation for the Supervision of Such Work



Steel Scroll-Case Erection—Made Possible by Smooth Coordination of the Work of Many Engineers in Different Fields of Specialization



A Generator in Process of Installation—Precise Planning Is Necessary to Coordinate Assembly of Hydroelectric Units

Engineers in the Contractor's Organization Lay Out the Work

Overseeing and Directing the Work—Another Job for the Engineer

well-known economist remarked, "The construction industry has been dead for ten years and doesn't know it." Why is this? These comments refer to one of our largest industries, which has an annual expenditure of eight to ten billion dollars and which is in many respects the foundation of our national prosperity.

There are, of course, many reasons for this confused situation. Among them are the following, which are offered in a spirit of sympathetic help rather than complaint:

1. Contractors are, first of all, individualists. Each goes his own way and in many cases is unwilling to recognize the industry or his duty, which is implied in the term "industry." It is estimated that there are about 40,000 contractors in the United States, not including subcontractors. The official spokesman for the industry, the Associated General Contractors of America, has a membership of only 2,500. Practically all contractors benefit from the efforts of this organization yet most of them are unwilling to join and accept the obligation of its support. As a result, it lacks funds and backing. This unwillingness of contractors to entrust the problems of the industry to authorized spokesmen has prevented those actively engaged in such work from doing an adequate job of handling the many difficulties of national, state, and local policy involved.

2. Contractors are poor advertisers and in general do not know how to sell their services. They have very poor public relations, and the public in general does not understand or know the industry. Frequently they are exposed to political attacks, and unfortunately there are enough cases of misdeeds to keep a number of contractors in a questionable status in the public mind. This however should not be construed to reflect on the entire industry.

3. One difficulty of course is that anybody can start out in the contracting business without technical qualification provided he has a little money or some credit, and such upstarts immediately compete with the highly qualified. Very often they even succeed in getting capital more readily than established contractors. Naturally, qualified contractors bid their jobs in terms of their experience and previous cost data. When inexperienced bidders come into the field and take away jobs at less than cost, it creates an almost hopeless situation which is inimical to the stability of the industry. The findings of a recent investigation disclosed that the average business life of general constructors is only seven years. A fair system of prequalification of bidders on prospective work has been under discussion for many years, but no general policies have been developed to date. The net result is, of course, serious instability in the industry, which tends to split it on many important issues.

4. Force-account and day-labor builders, both in public works and in other industries, engage in construction on a sufficiently large scale to serve as major competitors to the construction industry. Some of them take what they need in personnel and skill from the construction industry, use it, and dump it back on the industry when they no longer need it.

5. When big companies in other industries do their own work they have no direct interest in the construction industry, yet they enjoy such benefits as the construction industry provides. They may contend that they are saving money in this manner, or that they are expediting the work (sometimes reasonable claims but not at all representative), but in the end such companies are more concerned with the welfare of their own industry than with that of the construction industry. The National Association of Manufacturers, for example, is undertaking a comprehensive program of speeches, radio, advertising, and similar efforts towards establishing industrial unity and towards preserving the private enterprise system. The construction industry needs to undertake a similar program. A good first step toward industrial self-preservation would be for the spokesmen of the two industries to establish a policy of reducing or eliminating encroachment on each other's fields.

6. In many cases contractors have had insufficient regard for the welfare of their employees. The business by nature requires hiring and firing as jobs come and go. It is impossible to maintain large construction organizations without active contracts. While the solution of this problem lies in part in the development of a more progressive attitude in the minds of the contractors, it is not so much a question of developing greater security of employment as of seeing to it that employees who come to the job for a temporary period not only recognize this limitation but are given such assistance as is possible in removing some of the disturbing elements which affect their economy.

7. Another problem in the construction industry is that it has no clear-cut program of developing apprentices. Frequently it is impossible, because of the shortness of many jobs, to organize such a program, and contractors generally limit themselves to the training of employees as they turn up in the course of the work. However, such a hit-or-miss program of training does not provide the same opportunity for developing skilled personnel as can be obtained in manufacturing industries under a first-class modern training program.

8. It has only been within the past few years that the subject of labor unions has been approved for open discussion in meetings of contractors' associations. The necessity for proper labor relations and the need for authorized spokesmen for the construction industry, who can deal with the well-established spokesmen of labor, are so obvious as to require no further discussion here. A reduction in the wasteful practice of work stoppage will continue to require the constructive efforts of representative employer groups in formulating clear and fair labor policies. Collective bargaining is here to stay, and it brings with it many opportunities for the industry. It is likely that in time a degree of understanding will develop between construction management and construction labor under which their interdependence will become more fully recognized. Construction labor can help to stabilize the industry by demanding that construction work be done by the construction industry as a guarantee of its own future. Management might well take such an approach in developing union agreements which will assure labor of certain benefits, and under which labor participates in the protection of the industry.

9. In the past contractors have been inclined to keep their knowledge and experience to themselves so that other contractors will not be able to learn their trade secrets, but in recent years they have found it advantageous to disseminate their knowledge. Certainly they could benefit their own employees by having periodic technical meetings for detailed discussion of their own operations. It is surprising how little of this is done, yet such an approach would lead to a more closely knit organization and would develop an automatic and self-starting unity of purpose. The strength of an organization is increased tremendously when enough of its members think alike so that they tend to synchronize themselves.

10. There is a scarcity of technically trained personnel in contractors' organizations. As the art of construction becomes more precise in its technical methods,

CONVERTING TUNNEL SPOIL (UPPER LEFT) TO AGGREGATE (UPPER RIGHT) REQUIRES SOUND DESIGN AND EXPERIENCE

more young engineers, foremen, and superintendents must be able to think in terms of precise planning. More than the one or two men at the top must be capable of contributing to the solution of basic problems. In this respect progress is being made. The chief engineer for one of the largest contractors in the West recently remarked, "The boys [meaning contractors] are getting engineer-minded." By this he meant that contractors were realizing the values to be gained by raising the percentage of technically trained personnel in their organizations. The room for improvement in personnel and ability is just as great in the construction industry as it is in other fields, such as law, medicine, and government.

In the present national defense program we have seen a significant demonstration of the important part played by the construction industry. We have also seen a major demonstration of the need for proper construction planning. On the one hand, we have seen contractors erecting cantonments costing $20,000,000 within six months, or at a rate of better than $3,000,000 per month. Many other large projects had to be constructed at the same rate of speed and expenditure. In contrast, the manufacturers of armament, while developing their manufacturing facilities as fast as they could, yet put proper planning ahead of speed, and many of their operations did not get into full production for a year. Of course, the acquisition of tools and other facilities often took more time, but nevertheless there was an element of deliberateness and precise planning in each step of the program, and a remarkable job was accomplished as a result.

There is no question but that the construction industry has a tremendous obligation to consolidate its position and to develop strong spokesmen. It must impose self-discipline to guard itself and its members against abusive policies and practices, develop a strong and favorable relationship with those it serves and with whom it works, and contribute to a sound progressive labor policy. Competition must be preserved because it is the greatest stimulus towards generating greater ingenuity and new techniques of management and production, and thereby lower costs of construction.

It is obvious that not all work can be done by the contracting industry, but if this essential industry is to prosper, it should be given the opportunity to do as much of the available work as possible. The following recent quotation is significant: "One of the chief lessons to be learned from Germany is that a nation's freedoms are interdependent. When liberties are denied to one group, the chances are that they will in time be denied to others. President Roosevelt's recent statement that the 'rights of free labor as we know them today could not survive without the rights of free enterprise,' is an expression of that fact." The justifiable circumstances which brought about the creation of large governmental construction agencies in the last depression deserve to be reviewed. A continuation of such policies must be weighed against future needs; private enterprise and industry must be preserved to help carry the tremendous tax burdens.

We will probably always have a public works program designed primarily to relieve unemployment. Under such a program projects are justified on this basis rather than on the basis of economics or utility. An ominous sign, however, is that this is being accompanied by a trend away from the principle that such employment should be in private industry. The construction industry can make a major contribution here by having its spokesman meet with the heads of construction-awarding public bodies. By developing first-hand information and a better basis of understanding, they can build up a higher degree of mutual respect, leading to closer cooperation.

A brief attempt has been made here to outline some of the problems confronting the construction industry and to show the wide opportunities for improvement that lie ahead. Much is already being done towards meeting such problems, and in almost every part of the country there are progressive members of the construction industry who are contributing their time and energies to the building of a better industrial future. Unfortunately they are still in a minority, but they have already accomplished important things. In several large areas labor agreements have been developed which have stabilized wages, set up mediation committees, and eliminated work stoppages. The benefits of collective bargaining are being accepted. Sanitation and housing of employees on remotely located projects have improved tremendously in recent years. Plans are under way to organize a Research Institute to develop new ideas and methods applicable to the entire industry.

In the educational field, one contractor is financing a Chair of Labor Relations in one of our large technical colleges. Another stipulates in his labor contracts that he be permitted to employ a reasonable number of engineering students to assure them practical experience during summer vacations. A group of Mid-Western contractors is cooperating with an engineering college in giving a lecture course on contracting. We hope that, in time, the engineering colleges will meet their opportunity and develop an adequate system of training for young engineers interested in construction, who may eventually find themselves in positions where they can contribute to the solution of some of the industry's problems.

Our immediate objectives in such a training program should include the following:

1. Securing for private contracting a degree of recognition more nearly corresponding to its profound influence on the economy of the country.
2. Developing a clearer understanding of the difference between the work of the engineer in the contracting field and the engineer supervising contract construction work.
3. Training prospective technical personnel for the construction industry not only in the fundamentals of civil, electrical, and mechanical engineering, but also in the specialized problems of construction planning, accounting, law, and most important of all, labor relations.
4. Showing how engineers must be taught to think in terms of construction planning and in terms of the productive capacity of men and equipment.
5. Encouraging those who are interested to become competent to deal with labor unions and thereby improve the relationship between the labor movements and the contracting industry.

Buffalo Sewage Works Has Modern Laboratory

Bird Island Laboratory Aided in the Design, and Functions Now as an Essential Part, of the City's New Treatment Plant on the Niagara River at Buffalo, N.Y.

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A MODERN sewage testing and research laboratory has a strange motto: "If a man cannot build himself a laboratory out of two toothpicks and a piece of string, let him buy his fine results along with his fine equipment." It would seem that this motto was more appropriate for the temporary quarters in which the Bird Island Laboratory started its existence than in the carefully planned and well-equipped building it now occupies. But the motto has stuck, and serves to remind the personnel that equipment alone is no substitute for individual effort and initiative. And the achievements already credited to the laboratory would seem to justify the use of this motto.

RECOGNITION of the need for laboratory facilities in connection with sewage treatment plants has been growing on engineers. But in the past not much was done about it in most cases. Special interest therefore attaches to the Buffalo plant, where a complete laboratory was installed at the same time that the treatment plant was built. In fact, a temporary laboratory was set up prior to construction to act as a guide in the design. A description of the permanent laboratory and an outline of its valuable work are here presented. The paper was originally delivered before the Division of Water, Sewage, and Sanitation Chemistry of the American Chemical Society at the 102nd meeting of that organization.

The Bird Island Laboratory of the Buffalo (N.Y.) Sewer Authority came into existence on April 1, 1936, with the employment of the writer, for the express purpose of accomplishing two things: (1) to ascertain the extent of pollution of the Buffalo and Niagara rivers by Buffalo sewage, and the purification necessary to meet the standards set for the latter by the International Boundary Commission; and (2) to furnish the designing engineers, S. A. Greeley and Paul Hansen, Members Am. Soc. C.E., with information on sewage conditions and strengths for use in the design of the treatment works, and to assist in any other possible ways during the construction of the project. The Buffalo Sewer Authority, acting on the advice of its engineers, had voted the funds to establish the laboratory, during construction, as a part of its sewage treatment project.

A temporary laboratory was constructed and equipped during April 1936, on the second floor of the Custom's Building on Bird Island Pier near the site of the treatment works. This space was made available by the City Parks Department. Although there were only two rooms (a part of one is shown in Fig. 1) and although congestion was a problem during some of the more intensive studies, the small space was utilized effectively. The staff varied in size according to the amount of work to be done, but consisted generally of a chief chemist, three analysts (sometimes five), a field engineer, and a clerk-typist, with a sampling crew varying from 2 to 18, depending on the extent of the field studies under way.

During the first 17 months, major efforts were directed toward obtaining information relative to the design of the treatment works. In the next ten months, until operation of the plant began, the studies included some design problems, many tests in connection with the acceptance of materials for the disposal plant, and some research in preparation for its operation. The scope of the work performed in these 27 months may be indicated by a description of the five classes into which the 57 studies were divided:

Class 1. Boundary Waters. Studies were conducted on all the streams, rivers, lakes, harbors, and canals in and about the city of Buffalo. The purpose of these investigations was to obtain information on existing pollution and establish a basis for estimating the amount of wastes that can be diverted without polluting these bodies of water. Regular pollution surveys were made of the Buffalo and Niagara rivers and of the Park Lake, and tests were also made of Niagara Falls municipal raw water.

Class 2. Sewage Quantities and Characteristics. These studies were directed particularly toward obtaining data on the volume of sewage, quantity of suspended matter, chlorine demand, and storm effects, to aid the engineers in the design of interceptors and treatment plant structures. All the larger sewers and sewer districts in the city were investigated.

Fig. 1. Congestion Marked Temporary Laboratory Quarters

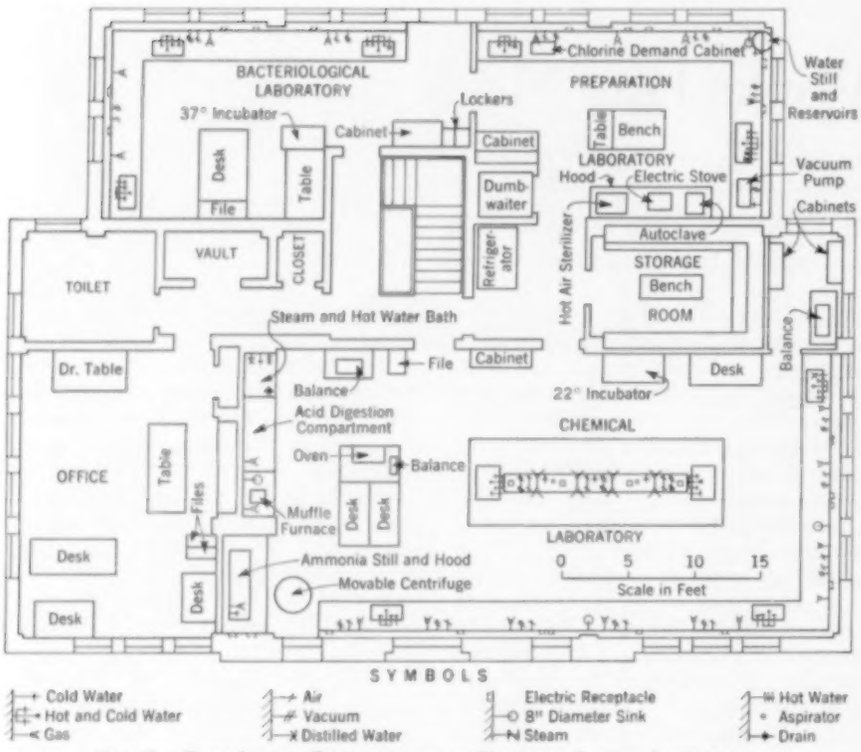

FIG. 2. BIRD ISLAND LABORATORY OF BUFFALO SEWER AUTHORITY

Class 3. Industrial Wastes. Fourteen individual industries were studied with a three-fold purpose: (1) to obtain data on the volume and character of the wastes and their influence on the design of the sewers and treatment plant; (2) to ascertain the effect (if any) of these wastes on sewer and disposal plant structures; and (3) to determine the effect of these wastes on the quantities of materials to be handled at the treatment works.

Six of these problems concerned the major industries discharging wastes directly into the Buffalo River. The studies showed that the wastes in question were heavily polluted and that the receiving stream had a very small dry-weather flow; further, that some of the wastes could not be taken into sewers or treatment plant without grave consequences, whereas other wastes were cooling water and needed no treatment. A special fund was set up to cooperate with these industries in reducing the pollution load on the stream without placing an undue load on sewers and treatment plants.

Class 4. Research. Investigations were made on seven problems to answer a number of questions in connection with the location and design of chlorinating equipment. Included were studies on up-sewer chlorination, chlorine contact time, methods of determining chlorine demand, effect of dilution on chlorinated effluents, and others. Inasmuch as these problems could not be investigated in the field, they became strictly research experiments and were conducted on a scale proportional to the factors of quantity and quality of the Buffalo sewage and the design of the plant.

Class 5. Special and Miscellaneous Problems. Of the 23 problems in this class, 10 were concerned with testing materials for the engineers. These included roofing, paint and varnish, wiring, aeration plates, fire clay, and others. The remaining studies were concerned with such problems as the effect of hydrogen sulfide water on steel piles, the location of a source of water supply for the treatment works, testing of water for use in concrete, tests on sulfur water wells, determining the source of water seeping into tunnel construction, the source of sewer-gas odors, causes of fish poisoning, and the problem of designing and preparing specifications for the permanent laboratory equipment.

The carrying on of experimental tests in connection with the construction of a sewage treatment works is not unprecedented, but, as far as the writer is aware, the establishment of a laboratory to function throughout the construction period is. A short review of some of the results of the laboratory investigations confirms the wisdom of establishing the laboratory. The notable accomplishments were:

1. Determining the extent of pollution of the boundary waters, thereby making possible comparative conditions before and after the inauguration of sewage treatment.
2. Testing of materials to determine if specifications had been met, particularly acceptance tests of the porous aeration plates and the development of techniques for analyses in connection with the acceptance tests on the sludge incinerators.
3. Development of a control test for use in determining the chlorine dosage after treatment of the sewage was begun.
4. Prediction of the chlorine demand, both average and probable maxima, and development of a predicted chlorine demand curve.
5. Determination by scale experiments that up-sewer chlorination on the interceptors was unnecessary, thereby saving the cost of a proposed up-sewer chlorinating plant.
6. Cooperative studies with industries on the Buffalo River, which resulted in the expenditure of several hundred thousand dollars by these industries to reduce pollution, which lowered the pollution load by approximately 50%.
7. Establishment of the fact that regrowth of bacteria in chlorinated effluents is no factor where the effluent is diluted by a large volume of water.
8. Preparation of reports on the effect of storms on sewage flow and other sewage characteristics and industrial wastes for the engineers.
9. Studies on the pollution of the City Park Lake and the extent of sludge beds and digestion in this lake.
10. Advice and assistance to the engineers in the design and construction of a permanent laboratory for the treatment works. Dr. F. W. Mohlman of Chicago was consultant to the engineers on the general layout of the laboratory, but the distribution of benches, design of drawers and cupboards, placement of equipment, plumbing fixtures and electrical outlets, as well as the specifications for equipment and supplies, were in accordance with the recommendations of the Bird Island Laboratory staff.
11. A trained staff of chemists (with equipment, reagents, etc.) was available and ready to undertake the work of the laboratory in connection with operation when sewage treatment began. An appreciable quantity of the equipment (including two sampling trucks) was available for operating purposes when sewage treatment was inaugurated and the permanent laboratory was put in service.

In the performance of the laboratory work, 28,940 samples were collected and 6,521 samples were analyzed, the results of the analyses being summarized and re-

FIG. 3. PREPARATION LABORATORY, LOOKING NORTH

ported in no less than 50 reports. The cost of operation of this experimental laboratory from April 1, 1936, to June 30, 1938, was as follows:

Construction and equipment (including two sampling trucks)	$ 5,380.16
Supplies and operating expense (including transportation and insurance)	6,886.99
Personal services (salaries and wages)	37,831.80
Total cost	$50,098.95

The distribution of these costs among the different types of work was approximately as follows:

CLASS	SCOPE OF WORK	COST
1	Study of boundary waters	$10,000
2	Study of sewage quantities and characteristics	20,000
3	Studies on industrial wastes, cooperative studies with Buffalo River industries	8,000 3,000
4	Research studies	6,000
5	Special and miscellaneous studies	3,000
	Total	$50,000

While under construction, the Bird Island Laboratory was under the administration of Edward P. Lupfer, M. Am. Soc. C.E., directing engineer of the Buffalo Sewer Authority, but the technical program and operations were in consonance with the desires and needs of the engineers, Greeley and Hansen; L. G. Williams and M. LeBosquet, Jr., of that organization were in direct contact with the writer as chief chemist. When the treatment works was put in operation, the staff, by taking civil service examinations, became a part of the operating personnel, under Harold Epstein, general manager, C. R. Velzy, M. Am. Soc. C.E., works superintendent, and J. W. Johnson, Assoc. M. Am. Soc. C.E., assistant works superintendent.

Seven months after operation of the treatment works began, the permanent laboratory for the plant was completed and the staff moved from the temporary quarters. The layout of the new laboratory was discussed in the *Sewage Works Journal* for October 1938 (before the final design was reached) by E. Hurwitz in comparison with other large sewage treatment works laboratories. Figure 2 shows the final layout and the present distribution of equipment. Interior views of the three laboratory rooms are shown in Figs. 3, 4, and 5.

Preparation of bacteriological media, washing and sterilizing of chemical and bacteriological equipment, preparation of lime and ferric chloride samples for analysis, and determinations of hourly chlorine demand comprise the work done in the preparation laboratory (Fig. 3).

Bacteriological tests, grease analyses, and some research and glass blowing are performed in the bacteriological laboratory (Fig. 4). Also in this room is an electric calculator by means of which weighted results and quantities can be quickly found.

The chemical laboratory (Fig. 5) is divided into two spheres of work. Samples of sewage are placed, each day, on the west side of the center bench (nearest the preparation room) and routine analyses begin there. The B.O.D. incubator and a leaded sink are handy to this location. Samples for suspended solids, total solids, or nitrogens are also set up at this point. Weighing, evaporation, drying, and ignition of samples, for any type of solids determinations, are performed in the area at the south end of the laboratory. By locating the two balances (one for rapid three-place weighing of sludge samples) in the vicinity of the evaporation bath, drying oven, and muffle, lost motion is eliminated and efficiency of operation is increased for the chemist charged with this work.

The north end and east side of the laboratory are reserved for titrations, color testing, apparatus for analytical tests on materials, gas, and B.t.u. analytical equipment, gage testing, and other analytical work. The small balance room houses a sensitive fine balance and reagent cabinets. All the preparation of reagents and weighing of samples for strictly chemical analysis are

FIG. 4. BACTERIOLOGICAL LABORATORY, LOOKING SOUTH

FIG. 5. CHEMICAL LABORATORY, LOOKING SOUTHWEST

performed in this room. Desks for the chemists are placed at locations convenient to their particular work. The chief chemist's office contains the reference and technical library, and the storeroom doubles as a dark room for the development and printing of pictures of plant and laboratory operation. Although the bench tops are of wood, it was found advantageous to place lead sheets around three of the sinks where acids are used extensively. At certain points where rough work is performed, a movable transite board is placed over the surface of the bench. Likewise, at certain points on the floors where wear has been excessive (near sinks and at the routine chlorine-demand bench), it was found advantageous to use a rubber floor strip, although the floors are waxed at regular intervals.

It is not a simple matter to estimate the cost of such a laboratory because some of the costs were included in the construction of the building superstructure, while the furniture was included in the general furniture contract, and also some of the equipment, which is now in use, was purchased during the first three years of operation. A rough estimate of $28,000 may be made, however, for such items as benches, utilities, present equipment, fixed apparatus, and supplies for at least a year's operation.

The present staff of the laboratory consists of 10 persons including the samplers. In addition to the collection of hourly samples, the samplers make hourly determinations of the chlorine demand of the raw sewage and instruct the chlorinator operators as to the proper chlorine dosage for the succeeding hour. With the exception of daily calculations and some monthly summaries of quantitative data, practically all the statistical records of the plant are kept by a statistician who is a part of the office staff. Janitor work is likewise afforded to the laboratory by the office staff porters.

Under the direction of the writer, the Bird Island Laboratory has been approved as a water analysis laboratory by the New York State Department of Health, almost since its inception. As an approved laboratory, it must keep statistical records of the number of samples analyzed and the number of chemical and bacteriological tests performed.

Samples from the sewage treatment works are collected from 24 points, with the largest number collected for routine testing. These samples include raw sewage, grit-free sewage, settling-tank influent, settling-tank effluent, raw sludge, digested sludge, supernatant liquor, sludge filter cake, ash, and others. Analysis of 24-hour composites of these samples is made daily, and bacterial tests are made on fresh samples at 6 different hours on both raw sewage and chlorinated effluent.

Statistics do not necessarily reflect the distribution of the work to the various functions of the laboratory and give no idea of the accomplishments of special investigations and research studies. In addition to routine chemical and bacteriological testing of sewage, and the analysis of materials purchased on contract, the laboratory has continued monthly surveys of the Buffalo and Niagara rivers, and has pursued investigations on 60 problems concerned with plant operation, stream pollution, research and industrial waste, giving active attention to 40 of these problems. Studies being pursued in the category of plant operation are concerned mainly with sewage chlorination and disinfection, sedimentation, grease removal, sludge digestion, chemical sludge conditioning and dewatering, sludge incineration and ash disposal, sludge soil conditioning, and analytical methods for sewage testing and sampling.

A number of papers and reports have come from the Bird Island Laboratory summarizing some of these investigations on stream pollution, sewage chlorination and disinfection, analytical tests, and operation. Unreported as yet are the investigations on methods for estimating coliform bacteria in sewage and chlorinated effluents, the relation of the volatile content of sludge to bound water, and a rapid method for determining sludge solids. Studies still in progress include (1) relation of the immediate chlorine demand to chlorine dosage control, (2) relation of partial chlorination to disinfection, (3) determination of sewage solids and solids balances, (4) variations in the analysis of chemically dewatered sludge and its use as a soil conditioner, (5) variations in the analysis of ash with particle size and its relation to abrasion, (6) chemical conditioning and elutriation of sludge, (7) methods for analyzing lime and ferric chloride, and (8) grease determinations.

Hourly control of chlorine dosage keeps expenditures for chlorine at a minimum while insuring efficient disinfection, and laboratory studies have indicated a program for reducing the amount of chemicals used in sludge conditioning. Cooperative contact with the industries has been maintained and studies have been made of the pollution load on the sewers of several industrial wastes. Servicing first-aid kits and fire extinguishers, and the preparation of foot-bath disinfectants and other cleaners are among the miscellaneous functions performed by the laboratory.

The cost of operation of the laboratory has been about $25,000 a year, or about $0.50 per million gallons of sewage treated. Budget requirements have been reduced each year, as needed equipment items have been acquired and supply stocks built up. It is expected that further reductions in expenditures will be possible and that the sampling crew may be somewhat reduced.

The Toby Creek Pressure Conduit

By J. Thornton Starr, Jun. Am. Soc. C.E.
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HIGH levees through industrial or residential areas bottle up tributary streams, sewers, and low-lying drainage areas. Expensive pumping plants or tributary levees tailing out to nothing at the edge of the river bottom area are sometimes the answer. In this case a unique pressure conduit was designed and built so that the formation of a pool above the conduit entrance created head enough to eject the tributary stream below the main levee and into the Susquehanna River even in spite of the flood-stage back pressure. This paper was originally presented before the Waterways Division at the Society's Baltimore Meeting.

PROBABLY the most difficult problem that confronts the engineer engaged in the design of local flood control works is the disposition of tributary streams traversing the area to be protected. On one of the projects designed and now being constructed by the Baltimore District of the U.S. Engineer Department, this problem was solved by the use of a pressure conduit. The Toby Creek pressure conduit, a unit of the flood control project for the adjoining boroughs of Kingston and Edwardsville, Pennsylvania, carries the flow of Toby Creek through the leveed area of these boroughs (Fig. 1). Kingston and Edwardsville are situated on the right bank of the North Branch of the Susquehanna River, directly opposite the city of Wilkes-Barre. Toby Creek is a tributary of the Susquehanna River.

During the flood of March 1936, approximately 60% of the area of these communities was inundated, with a resulting estimated property damage in the neighborhood of $4,000,000. A project to provide flood protection works for these boroughs was authorized by the Flood Control Act of 1936.

In addition to the pressure conduit, the system of works includes earth levees, three pumping stations to discharge sewage and local runoff over the levees during high river stages, and three relief culverts to discharge excessive runoff that may occur during low stages in the river. The method of handling Toby Creek, while not unique, is believed to be interesting. Some of the problems encountered in the design of the works are unusual. This creek, which rises in the mountains about eight miles to the northwest of Kingston, has a drainage area of 34.5 sq miles above its mouth and 32.8 sq miles above the borough of Kingston. The maximum probable flood is 28,600 cu ft per sec.

Prior to the construction of the pressure conduit, the capacity of the channel through Kingston and Edwardsville varied between 700 and 1,000 cu ft per sec. Any flow above 700 cu ft per sec resulted in damage to adjoining property. Between the upper limits of Kingston and the mountains the creek has a capacity of about 4,000 cu ft per sec within its immediate banks. Any flow in excess of this 4,000 cu ft per sec will overflow the left bank and will find its way to the Susquehanna River by overland routes. To confine this overflow to the creek would require extensive improvements, including the construction of high flood walls and the paving of the creek bottom, due to the resulting high velocities. As the cost of these improvements would be high, their construction is considered economically unjustified at this time.

Any structure designed to handle the confined flow of Toby Creek during floods in the Susquehanna River must extend at least to the elevation of the top of the levee system. This consideration determines the location of the upstream limits of the structure. Ground elevations place these upstream limits above the intersection of Division Street and the Delaware, Lackawanna and Western Railroad. From this point two routes were available for the location of the structure (whether it be open channel or conduit) which would discharge the flow of the creek outside the leveed area. One route was directly through the borough of Kingston to the river; the other followed the natural creek channel. The first route is shorter than the second, but as it discharges through a residential district, the cost of rights of way would be high. An open channel along such a route would be objectionable to local interests. The second route parallels the Delaware, Lackawanna and Western Railroad to the point where the creek crosses under the railroad, thence follows the creek to the river. As the bed of the creek could be utilized throughout the greater portion of the second route, with consequent low cost of right of way, this route was adopted.

Impounding Basin Above Conduit Entrance Creates Sufficient Head to Force the Tributary Stream Through the Pressure Conduit and Below the Levee Into the Main Stream

The capacity of the structures required to carry the flow of Toby Creek through the leveed area would depend, of course, on the economics of the entire project as well as upon the maximum probable flood to be expected on the creek. It would be uneconomic, as well as impracticable, to design for the maximum flood. Studies indicated that a pressure conduit was the most economical type of structure for this particular case. They further showed that the maximum capacity that could be pro-

Samples from the sewage treatment works are col-

sampling crew may be somewhat reduced.

vided was approximately 4,000 cu ft per sec. This capacity also happens to be the magnitude of the greatest flood that is known to have occurred on Toby Creek.

Three different types of structure were considered: a pumping station to discharge the flow of the creek over the levee during periods of high river stages, an open channel confined within levees or walls to discharge the flow into the river, and a conduit under pressure to discharge the flow against a head in the river. The high first cost and high maintenance and operation costs of a large pumping station indicated that this scheme was not feasible. An open channel would require the construction of high flood walls and several bridges. The high cost of construction and of right of way caused the rejection of this scheme. A pressure conduit showed a lower estimated construction and right-of-way cost than any of the other plans studied and was therefore adopted.

As has been stated, the upper end of the conduit was placed above Division Street. In this vicinity there was sufficient area with suitable topography for the construction of an impounding basin. The lower end of the conduit is located below the Delaware, Lackawanna and Western Railroad crossing of Toby Creek, near the point where the lower end of the levee ties into high ground. The total length of the conduit, exclusive of entrance and exit structures, is 6,391.7 ft.

FIG. 1. LOCATION MAP OF TOBY CREEK PRESSURE CONDUIT, WHICH PASSES UNDER TOWNS OF KINGSTON AND EDWARDSVILLE PA.

DESIGN OF IMPOUNDING BASIN AND CONDUIT

An impounding basin is necessary to provide sufficient head to discharge the design flood through the conduit. The topography in the area available for the construction of an impounding basin fixes the top of the levees surrounding it at El. 572. These levees were constructed principally of pervious material, having slopes of 1 vertical on 3 horizontal and of 1 vertical on 2 horizontal on the basin side and outside slopes, respectively. To reduce seepage through the levee, the inside slope is covered with an impervious blanket, ranging in thickness from 16 in. at the top of the levee to approximately 5 ft at the toe. The impervious blanket is composed of silt, some clay, and a trace of sand.

To prevent the levee from being overtopped by floods in excess of the capacity of the conduit, there is a spillway in the levee of 6,000 cu ft per sec capacity. This spillway is an ogee section with a crest 106 ft long at El. 566, allowing a maximum surcharge head of 6 ft. The computed discharge over the spillway was obtained by the Francis weir formula ($Q = CLH^{3/2}$) using for C a value of 3.94 for the surcharge of 6 ft and reducing it for lower surcharges. A stilling basin has been designed to reduce the velocity of flow after it passes over the spillway. Such overflow will traverse the boroughs of Kingston and Edwardsville and will pass through relief culverts provided through the levees for that purpose.

Studies that were made of the economics of circular and rectangular conduits resulted in the adoption of a circular section 16 ft 6 in. in diameter. At various points throughout the length of the conduit, the top of such a section would interfere with street and railroad crossings, and at those points special rectangular sections were provided. Where street elevations permitted, however, the circular section was used. Circular and rectangular sections are connected by transitions in which the "angle of cone," that is, the total angle of divergence and convergence, does not exceed 10°.

The grade of the conduit was kept low, the average being 0.13%, because of the necessity of depressing the upper end in order to provide sufficient overhead clearance for railroad crossings. The elevation of the invert at the lower end was fixed by the minimum permissible elevation of the bottom of the low-water channel.

In order to reduce the velocity of the flow discharging from the conduit to values that will not cause scour in the creek bed, a stilling basin is provided. A model was constructed of the outlet end of the conduit and of the proposed stilling basin, and a series of tests run to determine the most economical and efficient type of basin that could be constructed. Several types were tested. In the one adopted, the side walls are flared 1 ft in 5 and are battered 10 on 1. The slope of the bottom is a continuation of the slope of the conduit invert. Baffles were placed in what were shown by the tests to be the most efficient positions to create a hydraulic jump and thus reduce the velocity. Throughout the entire range of free flow, velocities below the stilling basin are within non-scouring limits. When the velocity increases beyond these limits, because the flow through the conduit is under pressure, the action of the sill and the downstream channel creates sufficient tailwater to form the hydraulic jump.

After the flow leaves the stilling basin it is conveyed to the river by means of a low-water channel, the construction of this channel being necessary because the bottom of the stilling basin is at a lower elevation than the bottom of the natural creek bed. During flows that exceed the capacity of the low-water channel, the water will spread out over the surrounding area with no damage.

TOBY CREEK OUTLET STRUCTURE HAS BAFFLES IN STILLING BASIN
At Left Is Sewer Outlet, Through Which Sewage Is Pumped When High River Stages Close the Tide Gates

Before the construction of the pressure conduit, Toby Creek served as an open storm drain, receiving and carrying off the discharges of various tributary sewers as well as overland flow to the creek. Since the conduit occupies the creek bed, it was necessary to construct intercepting sewers parallel to the conduit. These intercepting sewers, a 72-in. precast concrete pipe and a 42-in. precast concrete pipe, having their inverts paved with vitrified clay liner plates, were installed as shown on the map, Fig. 1, to the point where the pressure conduit leaves the course of the creek. From here a reinforced concrete sewer, constructed in the creek bed, will convey the flow of the sewers to a point directly above the Delaware, Lackawanna and Western Railroad bridge, where it will be discharged into the creek. The flow will then pass through the levee by means of two 6-ft square culverts equipped with automatic flood gates. During periods of high river stages the flow will be pumped over the levee.

In the computation of hydraulic losses, standard methods were used. The various head losses were evaluated in terms of velocity so that an expression could be formed for use in computing the discharge throughout the entire range of operation. These losses include entrance and exit losses, velocity head, friction head, losses due to enlargement and contraction (at the special sections), and losses due to bends. The friction head was computed by the use of Manning's formula ($H = 0.452\, n^2 \frac{lv^2}{R^{4/3}}$) using an n equal to 0.013.

Standard methods were also used in the design of the various structural features of the project.

Several factors affecting the detailed design of the project caused complications not usually encountered in the design of hydraulic structures. The unusual conditions are occasioned principally by the operation of the anthracite coal mines which form the major industry of the region.

Because of pumpage from the mines and the weathering of culm piles (mine waste), most of the surface and subsurface waters in the vicinity are acid. Toby Creek, which has a large active mine adjacent to it above the entrance to the pressure conduit, is particularly acid during periods of low flow. During high flows the natural alkalinity of the stream neutralizes the acid inflow from mine to culm piles. Numerous samples of water were taken from the creek and from large sewers emptying into the creek and tested for pH value. These samples were taken, of course, during periods of low flow. The results of the tests showed that the pH value of the creek water ranged from 2.9 to 3.3, indicating a highly acid condition. The low flow of the stream is thus quite harmful to concrete.

Several methods for abating this condition were considered: (1) paving the invert to a point above the low-flow line with brick or tiles, the joints being filled with a bituminous compound; (2) coating the invert with an asphaltic material; or (3) diverting all or a portion of the acid flow and increasing the concrete cover on the steel reinforcement so as to provide a band of concrete which may deteriorate without affecting the structural strength of the conduit. Estimates showed that the cost of the first method would be excessive. Furthermore, paving in a large conduit carrying flood waters would be subject to damage due to large rocks and boulders carried by the flood. The relative softness of an asphaltic material would lead to mechanical damage from debris and from silt and culm, both abrasive and both carried in suspension by Toby Creek. This precluded the second method. The third method was adopted as being the most practicable and least expensive. The pumpage from the mine at the mouth of the conduit was diverted into the 72-in. sewer already mentioned, and the cover of the steel reinforcement in the invert of the pressure conduit was made 6 in. so as to provide protection against any other acid.

Another result of mining operations is the subsidence of surface areas due to the removal of the coal beneath. Although it is the practice of the mining companies to leave sufficient supports to prevent subsidence in the immediate vicinity of waterways, so that their workings are not flooded, there is the ever-present danger that this practice will not be followed. Fortunately, these settlements are generally local and seldom cover a large area. To minimize the danger of failure of the conduit in case of a subsidence beneath it, the longitudinal steel reinforcement has been made continuous between railroad crossings, at which points it was necessary to provide expansion joints.

CONSTRUCTION IN THREE STAGES

The construction of the project has progressed in three stages. The first stage, extending from Sta. 4 + 32 to Sta. 55 + 18, was performed by hired labor, supplied through the WPA, with supervising personnel from the U.S. Engineer Department. The second stage of the work, which comprises the upper end of the conduit and the impounding basin, was constructed by Ralph Myers, contractor, of Salem, Ind. The third and final stage, the lower end of the conduit and the Woodward Pumping Station, is nearing completion. The contractor for this part of the work is T. M. Flanaghan of Reading, Pa.

All flood control work in the Baltimore District of the U.S. Engineer Department during the period of the planning, design, and construction of the Toby Creek pressure conduit has been successively under the direction of Col. E. J. Dent, M. Am. Soc. C.E., Col. W. A. Johnson, Lt. Col. H. L. Robb, and Col. F. C. Boggs, M. Am. Soc. C.E., District Engineer. E. W. Digges, Assoc. M. Am. Soc. C.E., is chief of the Flood Control Division, and S. D. Chittenden is chief, Design Section.

such a section would interfere with street and railroad

will spread out over the surrounding area with no damag-

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Sewer Design by Approximate Flood Routing as Applied to an Army Cantonment

By R. Lee Fraser, Jun. Am. Soc. C.E.

Engineering Department, Sanderson and Porter, Hot Springs, Ark.

THE routing of a "design flood" down rivers and through flood control dams is a recognized method of designing sufficient structure to control and regulate the waters of streams. This same procedure can be applied to sewers, and because of the uniformity of slope and storage volume, the detailed computations of flood routing can be simplified without sacrifice of accuracy. A practical method of applying the flood-routing technique to the design of a sewage-collection system is here described. This method of flood routing was used in checking the design of a new sewerage system at an Army cantonment in the South. The hydrograph computed by this means was checked by weir measurements at the outfall and found to be remarkably correct.

In choosing a procedure for applying the flood-routing technique to the sewerage system, the foremost thought was to simplify the computations and make their application as automatic as possible. The initial step was to assume the shape and quantity of the design flood at its origin in the upper reaches of the collection system. Army cantonments offer excellent conditions for this assumption because of their regular routine.

A hydrograph from a single barracks of 63 men was assumed, as shown in Fig. 1. Any further refinements were considered unwarranted, as the errors in the assumption of the shape of the hydrograph became less and less as the flood progressed down the system. It appeared that a design flood based upon approximately $6^1/_2$ gal per capita reaching the sewers during the early wash-up period would be reasonable. As the Army requires this routine to occur in about 30 minutes following breakfast, the design flood reaches considerable magnitude in the upper reaches of an interconnected system and has a short period of concentration.

To further reduce the computation, only the 5-min ordinate of the hydrograph (Fig. 1) was used in the computations, and the $2^1/_2$-min ordinate was computed only when necessary at junction points, where the floods combined. Eliminating the storage factor, as this value is fairly constant throughout the system, the procedure of routing the flood through the system was simply to assume the outflow from a $2^1/_2$-min reach to be the average of the inflow into the reach at the beginning and end of the preceding period.

The second step was to determine the base flow, considered to be that part of the total flow which more or less moves as a continuous stream, and which includes infiltration and intermittent discharges. In order to determine the base flow, the flood flow was subtracted from the total daily flow for which the system was to be designed. In the case of the Army camp, three flood flows were considered to occur: (1) the morning wash-up of 6.4 gal per capita (the design flow); (2) the flood flow assumed to originate at noon and to be two-thirds of the morning flow; and (3) the evening flood flow, equal in volume to the design flow, but of longer duration.

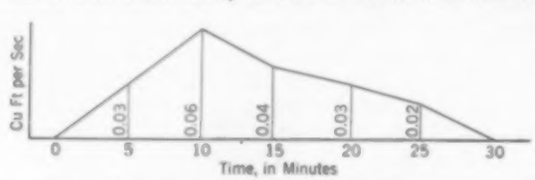

Fig. 1. Flood Hydrograph for a Single Barracks of 63 Men

For the design of sewers at 70 gal per capita per day, for a population of 20,000, the base flow would be computed as follows: a total flow of 1,400,000 gal less a flood flow of $2.66 \times 6.4 \times 20{,}000$, which equals 1,059,520 gal, to be distributed as base flow. The average hourly base flow of 44,150 gal equals 1.63 cu ft per sec. As the base flow will increase during the day, and during the periods preceding and following floods, the 1.63 cu ft per sec is increased about 20% to 1.96 cu ft per sec, which represents the base flow at the time of the design flood. This in turn is distributed over the various reaches in proportion to the population.

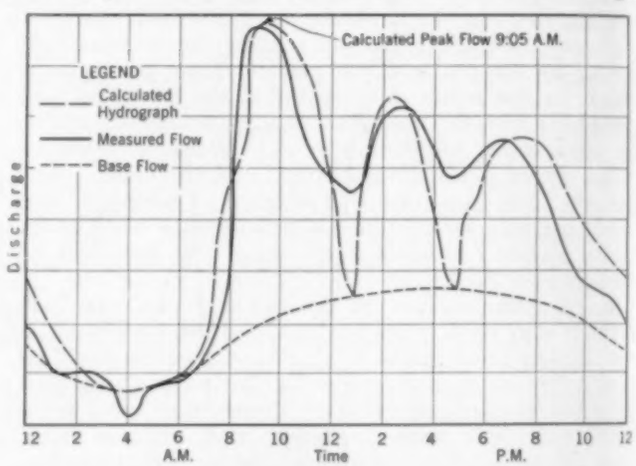

Fig. 2. Calculated Hydrograph for 24-Hour Period Compared with Actual Weir Measurements

In Fig. 2 is shown the calculated hydrograph plotted against the weir measurements taken at the sewer outfall. These measurements were made during construction, when the population was fairly constant. The population was centered at the upper ends of the system and at about the halfway point, thus making the hydrograph about the shape of the expected curve at capacity.

An average velocity for the flood flow must be chosen by the designer, and the final results will be influenced appreciably by this estimation. At the Army camp previously mentioned, where the outflow hydrograph was checked by weir measurements, the average rate of flood travel was assumed to be approximately the velocity of the average flow, which was about 0.7 of the peak flow. This rate of flood travel is open to question, and further experimental data will improve this type of calculation materially.

The outfall hydrograph resulting from the design flood is modified to represent the midday flood and the evening flood by the simple procedure of multiplying ordinates by the constant 0.66 for the midday flood, and by spreading out the time interval between ordinates for the evening flood. The base flow is proportioned throughout the day and night in a reasonable pattern.

By combining the hydrographs of the base flow, and of the morning, noon, and evening flood flows, the daily hydrograph is obtained for the design of pumping stations, treatment plants, and other structures. Combining the design daily hydrograph into a mass curve provides a convenient means of using these data.

It is the opinion of the author that flood routing may be applied to the design of other types of sewerage systems than those for Army camps. In the case of municipal districts, the hydrograph from individual houses or a combination of houses can be assumed within reasonable accuracy. As the average time of flood discharge into the sewage system is fairly stable for various districts within a municipality, hydrographs for residential, industrial, and business districts can be used in combination. This method of flood routing is flexible enough to take into account these various factors with few additional calculations.

The assistance of Edward A. Smith, assistant to the Constructing Quartermaster, and of George W. White, member of the Harwood Beebe Company (Architect-Engineer), in obtaining data and making this study, are greatly appreciated by the author.

A Conversion Slide Rule

By WOODSON WANG, M. AM. SOC. C.E.
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MANY operations in engineering computations can be facilitated by converting units on as lide rule from one system to another—such as meters to feet. Conversion of units can be made easy by pasting a piece of paper on the face of an ordinary Mannheim rule and marking on it the different conversion factors. It has been found that more than twenty conversion factors can be thus marked without confusion, but for ordinary purposes only those required should be marked.

Each conversion factor is marked with a fine ink line just opposite to the reading on the C scale, with the unit to be converted above the line, and the conversion units under it. The number of digits of the conversion factor should also be marked above the line. Thus, in converting one meter into 3.2808 ft, the fine line is drawn opposite to 3.2808 on the C scale.

The method of operation with the conversion slide rule thus made is just the same as that for an ordinary slide rule. For example, convert 36.4 meters into feet. Set 1 or 10 of scale C opposite to 36.4 on scale D. Move the runner to the conversion mark and find the reading of 119.5 on scale D. Since the slide extends to the left, the result has three digits.

It is suggested that such a slide rule could be specially manufactured. The slide ought to be made wider than the ordinary to contain as many conversion factors as possible, and the markings should be tinted in different colors to distinguish length, area, volume, etc.

High-Water Gaging

By FLOYD J. DORAN
CAPTAIN, COAST ARTILLERY CORPS, U.S. ARMY

MANY methods of computing storm-water runoff have been devised, in general excellent for the rainfall and other physical conditions under which they were developed, especially so when they are based on actual gaging of rainfall and runoff. There is, however, reasonable doubt as to the applicability to one locality of a method based upon conditions in a locality far removed. Therefore the method should be tested against comparative measurements of local rainfall and runoff.

The most satisfactory method of storm-flow gaging is done with an automatic stage recorder in a stilling well. This yields a hydrograph which may be correlated with records from automatic rain gages, but the cost is high—about $500 for a single installation. Results from a small quantity of data are questionable, and the gathering of an adequate quantity by the use of a large number of recorders is very expensive in equipment costs. However, reasonable interpolation of automatic rain-gage records may be made by the use of standard rain-gage records. Likewise it is possible to supplement automatic stage-recorder data with peak-runoff-rate records obtained by high-water gages that can be installed at a small cost. A single automatic installation on a drainage system can therefore be supplemented by a large number of high-water gages located above and below the point of automatic gaging.

The Storm Drain Division of the Bureau of Engineering of Los Angeles (from which the writer is on leave) has developed experimentally a method of automatically recording high water in conduits, open channels, and sumps, by the use of a coating of yellow dextrine on a white enameled surface. The powdered dextrine is mixed with water to a consistency suitable for its application as a paint. The dextrine coating dissolves in water in from 3 to 5 minutes, leaving a clear high-water mark. As the peak of storm-water flow in most cases lasts more than 5 minutes, a dependable record is secured. In installing a gage, care must be taken that no water other than storm water can come in contact with the dextrine. Two types of installation are used:

1. In a closed drain, a site is selected on a tangent where it can be reasonably assumed that all stages of flow will run parallel to the invert. A vertical white enameled stripe 3 in. wide is painted on the cleaned and dried channel wall from top to bottom. The surface to be painted may be dried quickly with a blow torch. When the enameled stripe is dry, it is covered with a coat of yellow dextrine paint. A more precise record

FIG. 1. FLOOD HYDROGRAPH FOR A SINGLE BARRACKS OF 63 MEN

calculation materially.

can be obtained at greater cost by painting the gage stripe in an offset stilling well.

2. In sumps, and in open channels where the velocity is very low, a perforated $^3/_4$-in. pipe, capped to keep out rainfall, is fastened to a pole or other stationary object. A $^3/_8$-in. smooth steel rod, covered with white enamel and having several wrapped-wire bumpers along its length, is coated with yellow dextrine paint and installed in the pipe. The offset stilling well is needed for gaging open channels with higher velocities.

Ordinarily a coating of dextrine is good for several months even in the moist atmosphere of the drain. At the close of dry periods of longer duration, it is well to renew the coating. Where ventilation of the surface is poor, mold tends to form and prevents the dextrine from dissolving under the action of storm water; this tendency can be prevented by mixing the dextrine powder with vinegar instead of water. The approximate cost per installation is $2.00 for a 5-ft length of pipe-enclosed gage, and 25 cents for stripe gages in enclosed conduits, exclusive of labor and transportation.

This method has uses other than that of supplementing automatic stage recorders. For example:

1. A large number of installations in drains having clearly defined drainage areas can be maintained for a number of years to obtain data for probability studies of the frequency of runoff, as discussed by W. W. Horner, M. Am. Soc. C.E., and F. L. Flynt, Assoc. M. Am. Soc. C.E. (TRANSACTIONS Am. Soc. C.E., Vol. 101, 1936, p. 140). It is required that drains so gaged have sufficient capacity to preclude surface impounding of storm water above the point of gaging. A number of suitably located automatic rain gages are needed for correlating runoff data with rainfall.

2. Where a drainage area is served by an inadequate drain, the residents of the area become accustomed to periodic flooding, and report it only in cases of extreme damage or inconvenience, thereby leaving the drainage engineer and other city officials with an erroneous impression as to the adequacy of the drain, with the result that relief construction is deferred until serious damage occurs. The use of stripe gages of either or both types at well-located points over the entire system of drains will keep the engineer informed at all times of the efficiency of their functioning and will enable him to anticipate flooding of serious consequence.

Simplified Cable-Sag Calculations

By C. M. GOODRICH, M. AM. SOC. C.E.

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ENGINEERS sometimes have occasion to calculate the sag in a cable under varying conditions of temperature and loading. The following method is proposed in the interest of simplicity.

For transmission-line spans with sags of less than one-tenth of the span, the parabola is now universally used in practice (Fig. 1). Let

w = weight per foot of span
L = span length
T = horizontal component of tension in cable
S = sag
$L + \Delta L$ = length of cable
E = modulus of elasticity
φ = coefficient of expansion per degree F

As an example, take a steel-reinforced aluminum cable of 266,800 cir mils, with an area of 0.2367 sq in., a maximum allowed T = 4,500 lb, L = 880 ft, E = 11,415,000, and φ = 0.00001. The weight per foot for the bare cable is 0.3407 lb; when encased in ice, 1.035 lb; the horizontal load in a wind under class B conditions, at 8 lb per sq ft, is 1.089 lb; and the resultant is 1.502 lb.

The sag in the plane of the resultant is $\frac{wL^2}{8T} = \frac{1.502 \times 880^2}{8 \times 4{,}500} = 32.31$ ft. $\Delta L = \frac{8S^2}{3L} = \frac{8}{3} \times \frac{32.31^2}{800} = 3.16$. This is at zero F, and with $^1/_2$-in. radial sleet, under a wind load of 8 lb per sq ft.

Let the temperature rise to 120 F, the ice fall off, and the wind be absent. The stretch due to the rise in temperature will equal $883 \times 120 \times 0.00001 = 1.06$ ft.

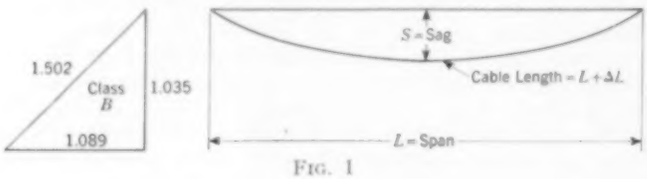

FIG. 1

For a trial T, multiply the first T by the load ratio trial $T = \frac{0.3407}{1.502} \times 4{,}500 = 1{,}020$ lb. The shrinkage due to the lessened load (4,500 − 1,020 = 3,480) will be $\frac{3{,}480 \times 883}{0.2367 \times 11{,}415{,}000} = 1.13$ ft. For the new T multiply the trial T by $\sqrt{\frac{\text{Old } \Delta L}{\text{New } \Delta L}}$. The old ΔL was 3.16 ft; the new ΔL is 3.16 + 1.06 − 1.13 = 3.09 ft. The new T then equals $1{,}020 \times \sqrt{\frac{3.16}{3.09}} = 1{,}030$, and evidently the shrinkage is unchanged. To check, the new sag and the new T may be calculated as follows: $S = \sqrt{3/8 \times L \times \Delta L} = \sqrt{3/8 \times 880 \times 3.09} = 32.0$ ft, and $T = \frac{0.3407 \times 880^2}{8 \times 32} = 1{,}030$ lb. It is interesting to note that the sag is almost the same under the new as under the old conditions.

Taking the same cable, suppose the temperature rises to 30 F, that the ice loading remains, but that there is no wind. Then trial $T = \frac{1.035}{1.502} \times 4{,}500 = 3{,}100$ lb. Shrinkage due to change in $T = \frac{1{,}400 \times 883}{0.2367 \times 11{,}415{,}000} = 0.458$ ft. The stretch due to temperature = $30 \times 883 \times 0.00001 = 0.265$ ft. Trial $\Delta L = 3.16 + 0.265 - 0.458 = 2.967$ ft. New $T = 3{,}100 \times \sqrt{\frac{3.16}{2.957}} = 3{,}195$ lb. New shrinkage $= \frac{1{,}305 \times 883}{0.2367 \times 11{,}415{,}000} = 0.4265$ ft. New $\Delta L = 3.16 + 0.265 - 0.427 = 2.998$ ft. New sag $= \sqrt{3/8 \times 880 \times 2.988} = 31.4$ ft. Check $T = \frac{1.035 \times 880^2}{8 \times 31.4} = 3{,}190$ lb, which is satisfactorily close to the new T of 3,195 lb. If the check T is unsatisfactory, one more cycle may be used to get a more accurate result.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Comments on Hydraulic Model Investigations

TO THE EDITOR: In Mr. O'Shaughnessy's admirable contribution on prototype confirmation of model tests, in the August issue, it should be noted in Fig. 5, the head-coefficient curve of the spillway, that prototype and model data overlap for only the short range of head from 11 to 18 ft. As the author implies, this is really too narrow a range for any definite conclusions.

The circumstance that the prototype discharge coefficients are based on end-gate tests may well explain why the coefficient at the higher head lies to the left of the model curve, as photographs showed more disturbance in the flow against the end piers at the higher head, presumably causing a smaller coefficient of contraction of the jet.

A very careful study of the effect of model scale on coefficients was made by Eisner and published as *Ueberfallversuche in verschiedener Modellgroesse*, Preussische Versuchsanstalt fuer Wasserbau und Schiffbau, Berlin, 1933. Its purpose was the very practical one of determining the discharge coefficient of an existing low dam, so that its round crest could be rated. The rating, by discharge measurements, of a dam extending over the entire width of a river is obviously not easy, so model tests were undertaken to determine and eliminate the scale effect. Cement-surfaced models of the following scales were made: 1:70, 1:35, 1:17.5, 1:8.75, and 1:4.375. The large size of a 1:4.375 model must be emphasized. The variation of the coefficients was so orderly that it permitted reliable extrapolation to the 1:1 or prototype value. In each case the larger model yielded the larger coefficient, while the 1:1 values were 5 to 10% higher than the 1:70 values. The likely explanation is that the larger models were relatively smoother than the smaller ones, as all were made of the same material.

Eisner's work is no reflection on the accuracy of model research. A 5 to 10% variation is well within the limits of the determination of the design discharge by the best hydrologic methods. Furthermore, in most instances the results will be on the safe or conservative side, if the model coefficients are less than the prototype coefficients. However, the hydraulic engineer should make note of the fact that prototype and model coefficients are not necessarily identical.

It can only be hoped that more worth-while comparisons such as Mr. O'Shaughnessy's will be forthcoming, as the need now in American hydraulics is not for model investigations alone, but for quantitative generalizations from the model results to assist the designing engineer in his work.

SAMUEL SHULITS, Assoc. M. Am. Soc. C.E.
Hydraulic Engineer, U.S. Engineer Office
Charleston, S.C.

Engineers in Ancient Egypt

DEAR SIR: I was interested in Professor Kirby's article on "Specifications and Plans of Ancient Times," in the July issue of CIVIL ENGINEERING, and in the subsequent discussion.

There is considerable information about engineers and architects of ancient Egypt in a book published in 1923 by Professor Englebach, Chief Inspector of Antiquities for Upper Egypt, who gave a clear exposition of how the obelisks were quarried, transported, and erected. He says that: "The erection of obelisks became the work of 'Specialists' in Egypt and several engineers left a record of their work on their own monuments. The kings did not permit them [the engineers] to inscribe anything concerning themselves on the obelisks but, as a mark of the king's favor, they were permitted to erect their own monuments and inscribe their professional achievements thereon."

One of these early obelisk engineers was Ineni, whose inscription on his tomb, No. 81 at Thebes, reads as follows: "I inspected the great monuments which he made (a great hall); with great pylons on either side of it made of fine Ayan limestone. August flagstaves were erected at the double facade of the temple, of new fir trees of the best of the Terraces, whose tips were of electrum (silver-gold alloy). I inspected the putting up of the great doorway called Amun-Mighty-in-Wealth; its huge door was of Asiatic copper, whereon was the Divine Shadow, inlaid with gold. I inspected the erection of two obelisks . . . and built the august boat of 120 cubits (206-6 ft) in length and 40 cubits (68-86 ft) in breadth for transporting these obelisks. They came in peace, safety and prosperity, and landed at Karnak . . . Its track was laid with every pleasant wood. I inspected the excavations of the cliff-tomb of His Majesty, no one seeing, no one knowing . . . I made fields of clay for plastering the tombs of the Necropolis. I was obliged to do a job which the ancestors had not had done. . . I became great beyond words; I will tell you about it, ye people; listen and do the good that I did—just like me. I continued powerful in peace and met with no misfortune; my years were spent in gladness. I was neither a traitor nor a sneak, and I did no wrong whatever. I was foreman of foremen, and did not fail . . . I never hesitated, but always obeyed superior orders . . . and I never blasphemed sacred things."

Another of the obelisk engineers was "Sennemut," who records his achievements on Tomb No. 81 at Thebes in the following "modest" language: "I was the greatest of the great in the whole land; one who had audience alone in the Privy Council. I was the real favorite of the King . . . I was foreman of the foremen; superior of the great . . . I was one to whom the affairs of Egypt were reported. That which the South and North contributed was sealed by me; the labor of all countries was under my charge. I was a noble who was obeyed; moreover, I had access to all the writings of the prophets; there was nothing which I did not know concerning what had happened since the beginning."

FRANK G. JONAH, Hon. M. Am. Soc. C.E.
St. Louis, Mo.

Stability of Vertical Slopes in Loess Soil

DEAR SIR: With reference to Mr. Turnbull's article, "Steep Slopes Used in Nebraska Loess Soil," in the September issue, many kinds of earths stand best with vertical faces, up to such heights as 2, 4, 6, or 8 ft, depending on the nature of the earth. Earth approaching loess in properties will stand vertically to greater heights, and true loess to much greater heights. The average face slope of $^1/_4$:1 in., cited by Mr. Turnbull, was probably made up to true verticals and short detrital slopes.

Many road and railway cuttings that give trouble—from slides—would have been stable if they had been made in a series of steps (see the August 27, September 24, and October 26 issues of *The Surveyor*, London). Loess—and to smaller heights other earths—stands better if vertical than at any steep angle. Rain driven against the face cannot create confluent runlets, which is fundamental in slope conservation.

Forty years ago I saw loess villages in Spain, the streets being vertical-sided cuttings and the houses excavated in the adjoining loess—the depth of streets and heights of dwellings about 12 to 14 ft to the nearby level ground surface—the whole, as it were, carved out of the deep layer of loess. Doors and windows opened on the streets, and chimneys were made through the loess roofs of the houses.

R. A. RYVES
Harlow, England

Engineers Are Not Economists

DEAR SIR: In the article by Bernard L. Weiner on "Engineers and World Economy," in the December number, there are a number of statements and implications that seem questionable to me. The first fundamental error is the assumption, without proof or supporting data, that engineers are fitted to solve economic prob-

lems. The engineer is fitted by training and experience to design air depots, bridges, engines, and other physical things. Mr. Weiner says "The causes of the economic crises are, unfortunately, not physical . . ." Yet he assumes that the engineer, who is trained in the physical sciences, is "peculiarly fitted" for the task of solving the economic problems of the country. Walter Mathesius, vice-president of the U.S. Steel Corporation of Delaware, states in the December number of *The Journal of Engineering Education* (page 308) "While these technical graduates may be able to solve specifically assigned and difficult engineering problems, their trained engineering minds tend to focus narrowly upon the designing, construction, or production phases of their tasks and often fail to grasp the importance of essential economic, sociological, and other fundamental relationships."

The second fundamental error is the assumption that economists and political scientists are ignorant of the scientific method. Mr. Weiner suggests "That surveys of both the capacity to produce and of the capacity to consume must be made . . ." Literally thousands of such surveys have been made, and every "factor that even remotely affects the national economy . . ." has been questioned and reexamined many times by men who are spending their lives in such work. Mr. Weiner does not seem to be familiar with the vast amount of work that has been done in this field or with the methods used. "Research" certainly has not been "confined merely to such superficial studies as the charting of market trends."

The third fundamental error is the assumption that governmental economic policies are shaped by economic experts. If a bridge is to be built, no governor or legislator thinks of suggesting a design for the structure, but legislators (and some engineers) seem to think they can solve the vastly more complicated economic problems of the country even though they have no training in such work. Let us give the men who have made a life study of economic problems a chance. Contrary to popular opinion, economists do agree on fundamental principles and on procedures which would bring beneficial results.

At present we require that a man in charge of engineering work be an engineer, that a man in charge of medical work have a medical education, and that an army man be trained in military work. But a mayor or a legislator need know nothing of government! This condition might be remedied by requiring that each candidate for an office show some evidence of his ability to perform the duties of the office. Another, and perhaps more practical, remedy would be to promulgate the idea that technical, economic, and political problems should be referred to men trained in these sciences.

Let us continue to do well the work for which we are trained and then use what influence we have to promote the idea that any job is apt to be better done if an expert does it, and that the business man, lawyer, doctor, or engineer is not an expert economist or political scientist, though he may be outstanding in his own profession.

GEORGE L. SULLIVAN, M. Am. Soc. C.E.
Dean, College of Engineering
University of Santa Clara
Santa Clara, Calif.

Studies in Driving Timber Piles

DEAR SIR: The article, "Don't Hit Timber Piles Too Hard," by Lt. Comdr. T. C. Bruns, in the December issue, certainly deserves the close attention of all engineers who are interested in foundation construction. Undoubtedly many piles are ruined in driving and left in place in the mistaken belief that no damage has been done, and that they will support the load which is indicated by the result of the last five blows of the hammer in accordance with the *Engineering News-Record* formula. An intelligent application of this formula will give reasonably accurate supporting capacity for each pile, but an attempt to apply the formula without knowing how it was derived can sometimes be serious. I believe that a reprint of Wellington's comments relative to the formula, in *Piles and Pile Driving* (published in 1893), would be extremely valuable to all engineers just now.

Commander Bruns' experience in finding damaged piles is substantiated by an example in Chillicothe, Mo., where a concrete overpass was constructed in 1929. The writer was project engineer on this structure, and made the accompanying photographs. Based on observed penetration of an untreated test pile, treated southern pine piles, 30 ft long, were specified for the bents along the railroad tracks. A 2,700-lb gravity hammer in swinging leads was used for all driving. When the first bent was driven, very irregular penetration was obtained, varying from about 10 to 25 ft. Usually the piles stopped suddenly, the hammer bouncing as though the pile tip had encountered a rock. Exploration with a soil auger, however, revealed nothing harder than sand clay at any depth.

In the second bent two steel-shod piles were driven as test units. At a penetration of about 10 ft the hammer bounced severely; but driving was continued with reduced drop until the pile was again penetrating half an inch per blow. Before the piles were entirely driven, they had stopped at least three times, just as if they had hit a rock that had given way to permit further penetration.

Because of the peculiar action of these test piles, a pit was dug to the stratum where first resistance was encountered and a 40-ton loading test was made. This stratum was not rock as expected but merely blue sand clay—very dense, but removable with pick and shovel. It was 12 to 24 in. thick. As a result of the loading test, it was decided to eliminate the piles, and to extend the columns down to a footing which was placed directly on the hard stratum.

The accompanying photographs show what we uncovered in excavating for the extra depth. Each time the piles had let loose, they had sheared off beside the lower shaft, thus placing about 20 ft of pile in a 5-ft depth. The steel-shod tips never penetrated the sand clay stratum. Evidence of the damage they sustained is clear in the before and after pictures.

This experience is offered in the belief that details are sometimes of value to supplement a general report. Experience and judgment are of inestimable value in pile driving. Both can be rounded out by knowing what happened at some other place. The structure was designed and built under the supervision of the Missouri State Highway Department, with the Pioneer Construction Company of Kansas City as contractors.

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Acting Head, Department of Civil Engineering, South Dakota State College
Brookings, S.Dak.

STEEL TIP PREVENTS BROOMING BUT DOES NOT PREVENT BREAKAGE OF TREATED TIMBER TEST PILES
Steel Tip Before Driving; Steel Tips After Removal; and Broken Pile After Removal

SOCIETY AFFAIRS

Official and Semi-Official

E. B. Black, Society President, 1942

To the many friends of E. B. Black, it is common knowledge that he counts the Society among his foremost interests. And this is not because he lacks other absorbing activities. Of course, his family and his professional work come first. Then, in addition to the Society, there are the Boy Scouts of America and his alma mater, the University of Kansas. In spite of their extent and variety, he gives generous support to them all.

In common with many other prominent Americans, E. B. Black inherited a flair for his life work. When he was a boy of only three, his family moved to Meade, Kans. Shortly afterwards his father, Moses Black, became county surveyor, holding that position for about forty years—until shortly before his death.

Young Black acted as his father's rodman and chainman on land surveys and in laying out irrigation ditches. It was this experience that gave him his first desire to become an engineer, and perhaps more important, also supplied an invaluable ground work, a practical point of view. A proof that he has not forgotten this early work is the fact that today he keeps at his elbow as one of his most prized possessions the transit his father used throughout his life. It is an old instrument, without a serial number, date unknown. But it and its scarred box symbolize the great contribution made by one conscientious surveyor in a pioneer country. It also symbolizes the devotion of that surveyor's son to the same high ideals of character and accomplishment.

Ernest Bateman Black

The son inherited not only love of the profession but also personal qualities valuable to an engineer. Moses Black won a reputation for thorough work and rigid honesty—there was never any question as to the integrity of his survey. E. B. Black has these same virtues—his work has reflected honesty and thoroughness ever since his University days—traits that have helped him to his present professional eminence. He is tireless, spending long hours at his desk completing in meticulous detail the assignment on which he is working.

In broad outline, E. B. Black's professional record is quickly told. Following graduation from the University of Kansas in 1906, he spent three years in Toledo before joining the J. S. Worley Company in Kansas City, after which came the present partnership of Black and Veatch, begun in 1915. The firm has specialized as consultants in water supply, sanitation projects, power development, and valuation in the Midwest and Southwest. During the first World War, Mr. Black's firm was construction engineer for three army cantonments. His work on these projects led to his recent appointment by the Quartermaster Corps of the Army, as head of its water engineering branch for several months. His firm has subsequently been architect-engineer for Camp Chaffee, near Fort Smith, Ark., and has also done engineering work at Camp Robinson, and on an air base.

During the many years that Mr. Black has been in engineering practice, his office has employed hundreds of engineers. Young graduates who are fortunate enough to receive their first experience under his supervision find him patient and considerate of their shortcomings and always ready with helpful suggestions to aid them in their professional progress. His success as an employer is evident from the fact that a number of engineers have had a continuous employment with the firm for more than twenty-five years.

With all his other activities, he has somehow found time to give freely of his energies to the affairs of local technical societies. He was one of the early presidents of the Kansas City Engineers Club, and was president of the Missouri Society of Professional Engineers during the time that this organization succeeded in securing legislation for the registration of professional engineers in Missouri. He is deeply interested in the curricula of engineering schools and each year finds time to deliver a series of lectures before the senior enginering class at his alma mater, the University of Kansas. He has also been president of the University's Alumni Association.

There is another honor for E. B. Black that is something of a record in Kansas City—he has been president of the Kansas City Area Council of the Boy Scouts for three consecutive years. He takes a deep interest in this work, which is perhaps his chief hobby. To it he gives the time others might devote to golf—except what he spends in his office, which includes many nights and Sundays.

As for the Black home, it is typical of all that is best in American life, characterized by simplicity of taste and complete wholesomeness. Mrs. Black is a graduate of Miami University in Ohio, and the four children, two boys and two girls, are all upholding the family tradition for scholastic accomplishment. They also love the outdoors, riding and swimming and "scouting"; a cabin in the Rockies has long been their summer retreat. Mrs. Black keeps up with the children and at the same time manages to be a charming hostess. It is quite a lively household—and a very hospitable one. As an illustration of this, the story is told that once when "E. B." drove home he found so many automobiles in the driveway and the street outside that he went back to his office and phoned that he would wait to come home until there was room for him.

His devotion to his business, his family, and his professional affairs, leaves him little time for outside interests. However, he has a great fondness for amateur photography and is never without his camera. He professes to be a rank amateur, but his friends admit that he gets excellent results even though he refuses to use a light meter. Stills, movies, and color photography are all in his repertoire. Sometimes he uses this hobby to gratify his sense of humor. For example, he once photographed in color the elaborate Christmas display of a real estate company near his place of business, because it contained an artificial poinsettia of enormous size. The photographs included several bystanders to give scale, and were found very useful by Mr. Black in backing up his claims—particularly to some of his California friends—regarding the size of the flower growth in his home town.

In the Society Mr. Black has been a corporate member for over thirty years. He has long been an assiduous worker both locally and nationally. Thus he served a term as Director from the Sixteenth District for the years 1932-1934. More recently he has been chairman of the Engineering Economics Division.

There is never any business too important to keep him from telling a story in keeping with the occasion. Typical of his yarns is the story he recounts of how he was one of three reserve officers examining younger men for a continuance of their commissions. During a lull in the proceedings, there came an opportunity for questions and one of the reviewer board asked a candidate whether he had familiarized himself with the "revised Manual of Arms." The candidate made some stumbling apology in an attempt to excuse himself. Meanwhile, as he confides, Mr. Black sat in confused silence, realizing that he himself had not kept in touch with such matters. After the hearing was over, the board sat for some moments and finally the chairman turned to the questioner and demanded, "What the dickens is this new Manual of Arms?" Came the reply, "Blessed if I know, I never heard of any, but I thought there might be one."

To the office of Society President, E. B. Black will bring a personality, a dignity, and a devotion that will assure a successful term. He has not only a calm and judicial temperament, but enormous energy and untiring capacity for work. His accomplishments have come from assiduous effort, devoid of any pretense or bluff. In other words, he is genuine, solid, balanced, and dependable—a good type of man to serve the Society as President throughout the year 1942.

The Eighty-Ninth Year

Extracts from the Annual Report of the Board of Direction for the Year Ending December 31, 1941

DEFENSE, CIVILIAN PROTECTION, AND WAR EFFORTS

The Society has been generally attuned to national defense, civilian protection, and war efforts throughout not only this year, 1941, but even since early in the year 1940, when the then President of the Society was commissioned chairman of a Construction Advisory Committee to the Army and Navy Munitions Board. This committee, commissioned by the Secretary of War, consisted of six members, five of whom were members of the Society, and upon requests from the Army and Navy Munitions Board, or upon its own initiative, consulted frequently with that Board as to prospective construction programs for both the Army and the Navy.

Not only through such committees, or designated representatives, but through its staff and through the many members of the Society who have been called into service either in a military or civilian capacity, the Society has been related, either officially or unofficially, to almost every phase of the defense, civilian protection, and war efforts.

NATIONAL DEFENSE

At the request of the Army and Navy Munitions Board, expressed through its Construction Advisory Board, the Society's headquarters staff, in June of last year, gathered data from 3,225 engineering firms or individuals capable of rendering prompt assistance to the Government in terms of the design and supervision of the construction of needed Army, Navy, and industrial facilities. These data were made available to the several federal agencies engaged in the construction program.

In several instances Society representatives have been designated to committees having the nature of advisers to official units of the Federal Government. One such committee has the function of determining how best a larger proportion of engineering talent may be made available to the service of the Government.

Another committee, called the Engineers' Defense Board, consists of five representatives of six collaborating engineering societies, of which the Society is one, to advise the Office of Production Management as to how best, and to what extent, engineers can help in the conservation of metals essential in armament production, steel being one of the most important.

These and similar services rendered by the members of the Society thus appointed to committees, or by the staff, may properly be considered as practical efforts made in the spirit of the resolution passed by the Society, in formal session last July, when there was pledged to the President of the United States complete support of his efforts in behalf of the national defense and unqualified endorsement of any action which, as Commander-in-Chief of the military forces, he may deem necessary in furthering defense.

The number of members of the Society who have been called into the armed forces of the United States, or are engaged in civilian capacities in the designing and supervision of emergency construction of all kinds, is impossible to state. It is safe to say, however, that thousands of the Society's members are thus engaged.

CIVILIAN PROTECTION IN WAR TIME

Established in July 1940, the Committee on Civilian Protection in War Time has continued to study those operations which should be instituted for the protection of life, health, and property in communities which may be subject to aerial attack.

The Committee deemed civil engineers preeminently capable of assembling and distributing technical data in the fields of structures, transportation, sanitation and public health, power, and emergency control. This it has done throughout the year.

That this work might be effective in all parts of the country, local committees of like character were set up in 62 of the Society's Local Sections, and to the members of these committees have been distributed a total of approximately 6,200 documents or memoranda pertaining to the different phases of this work of civilian defense. In letters addressed to the governors of the states and to the mayors of 75 cities, the services of these committees have been proffered and many of these local committees have been active with respect to their own communities.

POST-WAR CONDITIONS

Prior to the time of change in the United States, from a state of emergency to the declaration of war, a Committee on Post-War Conditions was established to give its attention to the several methods proposed for the employment of those then engaged in defense work, when a period of dislocation should occur at the close of the emergency program.

That committee found several bills in the Congress making provision in varying degrees for this anticipated unemployment, which would certainly affect, in high degree, those many civil engineers now engaged on defense work of all characters.

The committee's report, adopted by the Board of Direction, suggested certain administrative procedures looking towards the limitation of proposed projects to those that would be deemed to be, in the long run, worthwhile in every respect, and to this end suggested the establishment of a strong independent Technical Board of Review which would have authority to cull out proposed projects of an improper and uneconomical character. This and other recommended administrative procedures were presented at a hearing held by the Senate Committee on Education and Labor.

MEMBERSHIP

As has been said so many times, again it may be said that membership in the Society in 1941 has reached its all-time high. Total

membership at the close of the year was 17,438. Within this over-all figure, moreover, are some interesting details. Net gain for the year was 776. Not since before the depression, now a dozen years ago, has there been so small a percentage of loss through failure to pay dues, or by resignation, or because of the stipulated age limit for Juniors, offset by the number of reinstatements. In 1941 the loss that might be called voluntary was only 1.44% of the membership. In 1928, the best preceding year, the corresponding voluntary loss was 1.88%, when the total membership was some 4,000 less than it is now. The percentage of Juniors has continued its persistent increase. Juniors now constitute 27.4% of the total membership.

FINANCES

It has been a good year for the Society financially. Excess of income over expenditures is again somewhat larger than usual, approximately 6.3% of income. This is attributable largely to four items—two with relation to decreased expenditures, namely, cessation of financial support to American Engineering Council, and smaller staff expenses due to changes in personnel. Two items of income were in excess of anticipation: increase in membership and the promptness in payment of dues netted some $13,680 more than anticipated, and income from the sale of advertising space in CIVIL ENGINEERING increased 16.4 % over 1940.

The Society is fortunate in the steady income received as rental on its former home at 220 West 57th Street. When that property was rented in 1926 it was mortgaged for $200,000. The new lease provided a considerably larger annual rental of which, it was decided, some portion should be devoted to the retiring of the mortgage, leaving the property free and clear. Another portion of the increased income, it was decided, should be set aside annually in a fund to provide for a possible emergency. This year that fund was augmented by the transfer to it of $15,000 from excess of income over expenditures in 1940.

READING ROOM OF THE SOCIETY

The registered attendance at the Reading Room during the year was 1,639.

Two hundred and twenty-one periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and daily newspapers.

LOCAL SECTIONS

The number of Local Sections, 64, is unchanged since last year, no Section having been organized or disbanded during 1941.

MEMBERSHIP OF TECHNICAL DIVISIONS

City Planning	738
Construction	3,738
Engineering Economics	932
Highway	1,665
Hydraulics	2,270
Irrigation	614
Power	775
Sanitary Engineering	1,411
Soil Mechanics and Foundations	1,872
Structural	3,162
Surveying and Mapping	1,182
Waterways	787
Total	19,146

STUDENT CHAPTERS

During the year one new Student Chapter was chartered, making a total of 121. The new Chapter is at the University of Connecticut, Storrs, Conn.

Brief Review of the Eighty-Ninth Annual Meeting

Tenor of Program Stresses the Engineer's Place in the War Effort

WEATHER like spring greeted visitors to New York for the Eighty-Ninth Annual Meeting of the Society, and members from Albuquerque and the Coast carried their coats on their arms and remarked that New York weather reminded them of home. Encouraged by the weather and determined to carry on in spite of war and taxes, visitors from far and near gathered on January 21 for the four-day session of the Eighty-Ninth Annual Meeting. In all, over 1,600 participated in one or more of the events on the program. The lobby and the fifteenth floor continually overflowed with members and visitors.

In accordance with time-honored custom, the program of the opening session on Wednesday morning centered about the conferring of honorary memberships and prizes. Four of the five newly elected Honorary Members received their certificates in person—Ralph Budd, William Kelly, Henry E. Riggs, and Henry W. Waite. The fifth recipient, John L. Savage, was out of the United States on secret official business. His whereabouts and the nature of his work were not disclosed, but we were assured that he was in one of the very hot spots doing important work for the Government.

Nine winners of Society prizes were present to receive their awards: John A. Van den Broek, the Norman Medal; Earl I. Brown, the J. James R. Croes Medal; Oliver J. Todd, the Thomas Fitch Rowland Prize; Samuel A. Greeley, the James Laurie Prize; Fred Lavis, the Arthur M. Wellington Prize; Elmer Rock, the Collingwood Prize for Juniors; Thomas H. Wiggin, the Rudolph Hering Medal; E. Leland Durkee, the Construction Engineering Prize; Thomas R. Camp, the Karl Emil Hilgard Hydraulic Prize. The only prize winner absent was Sigurd Eliassen, joint winner with Oliver S. Todd of the Thomas Fitch Rowland Prize. Mr. Eliassen is now a hostage to war in Oslo, Norway. Although we believe he is getting our publications all right, the Society received no work from him and was unable to contact him directly.

As a coincidence, it happens that three of our prize winners had known each other in China, where they had done engineering work. All three in fact were members of the Chinese-American Society of Engineers. They are Fred Lavis, Oliver J. Todd, and Thomas H. Wiggin. Their get-together had a definitely Chinese flavor.

Reports of the Board of Direction, the Secretary, and the Treasurer, and a brief business meeting were also a part of the morning session, which was brought to a close with the enthusiastic introduction of the President-elect and the other new officers. Retiring President Frederick H. Fowler completed the morning meeting by a gracious presentation of his successor, E. B. Black.

Luncheon, served in the Engineering Societies Building, was an unusually popular event, and so many were there that it had to be served in relays. The last luncheon guests were still eating while, in another part of the large room, chairs were being placed in preparation for the meetings of the Construction, Waterways, and Sanitary Engineering Divisions. These three Division sessions were provided for simultaneously by the closing of folding doors. Meanwhile the general session was getting under way in the large auditorium. This consisted of an interesting and valuable program sponsored by the Society's Committee on Preparedness for Post-War Conditions. Papers on "A Practical Approach to the Public Works Program," "The Public Work Reserve," "Highway Construction in the Post-War Period," and "Municipal Public Works Construction" were read and discussed with interest. At the same time, in another room, the Student Chapter Conference was addressed by retiring President Frederick H. Fowler, who spoke on "The Future for Young Engineers in War Time."

As usual, the outstanding social event of the Annual Meeting was the formal dinner dance held at the Waldorf-Astoria on Wednesday evening. A reception for the incoming President and the Honorary Members constituted an interesting part of the program. The food, music, dancing, and company were all excellent and the evening was over all too soon.

The daylight hours on Thursday were devoted to eight sessions of Technical Divisions—Structural, Surveying and Mapping, Hydraulics, Soil Mechanics and Foundations, City Planning, Sanitary Engineering, Engineering Economics, and Highways. The Structural Division dealt with the war problems connected with the effects of bombing on structures. The Surveying and Mapping Divi-

1941 Board of Direction of the Society

Starting at the near corner of table and proceeding clockwise: Joseph Jacobs, Vice-President, Zone IV; Harold M. Lewis, Director, District 1; Edward S. Bres, Director, District 15; Henry E. Riggs, Past-President; Charles T. Leeds, Director, District 11; H. W. Hudson, Director, District 1; George L. Lucas, Vice-President, Zone I; Armour C. Polk, Director, District 10; Charles H. Stevens, Vice-President, Zone II; E. E. Howard, Director, District 16; C. M. Blair, Director, District 2; Clifford G. Dunnells, Director, District 6; William N. Carey, Director, District 7; John W. Cunningham, Director, District 12; Gustav J. Requardt, Director, District 5; Ernest P. Goodrich, Director, District 1; Lazarus White, Director, District 1; Ralph B. Wiley, Director, District 9; George B. Massey, Director, District 8; Charles B. Burdick, Vice-President, Zone III, Charles G. Hyde, Director, District 13; Carolina Crook, Secretary to Mr. Seabury; George T. Seabury, Secretary; Frederick H. Fowler, Past-President; John P. Hogan, Past-President; Sanford W. Sawin, Director, District 4; and Robert B. Brooks, Director, District 14.

sion held an open meeting of its executive committee. The Hydraulics Division conducted a symposium on the hydrology of elements contributing to floods, while the Soil Mechanics and Foundations Division gave a résumé of the program and accomplishments of the Committee on Sampling and Testing, with emphasis on undisturbed sampling. The City Planning Division held a symposium on the effect of defense project locations on official city plans, and the Engineering Economics Division considered cost allocation for multiple-purpose water projects as applied to the Willamette and Boulder Canyon projects. Of timely interest were the papers of the Sanitary Engineering Division, especially the one on the "Design of Sanitation Facilities for Military Posts." The Highway Division at its session considered the subject of parkways in the New York metropolitan area and the Pennsylvania Turnpike.

Thursday evening, members and their guests gathered at Manhattan Center, where the annual Smoker was held. The ballroom, newly arranged and decorated, was large enough to accommodate the numerous members and guests who assembled there. The excellent entertainment was accompanied by smokes and refreshments and followed by a social evening. Engineers from all over the country took advantage of the opportunity to meet and compare notes with old friends.

The ladies' luncheon on Thursday was a great success. This was followed by a demonstration and explanation of colors and their effects on human reactions. This exploration of the magic world of color took place in the ballroom of the Hotel Biltmore, and afterwards many of the ladies visited the exhibition of pencil drawings on the 15th floor of the Society building. This exhibition shows the work of Miss Lili Réthi, who has contributed numerous drawings of engineering projects to Civil Engineering.

At noon and night on Thursday there were many luncheons and dinners held in connection with the Annual Meeting by college engineering groups. Separate get-together meetings were held by the alumni of Massachusetts Institute of Technology, Rutgers, Syracuse, Cornell, Illinois, Chi Epsilon, and others.

Friday morning started out with movies of one of our largest army cantonments followed by construction movies of the Pennsylvania Turnpike, the Long Island Parkway System, and the large Santee-Cooper power, navigation, and flood control project in coastal South Carolina. Members taking the excursion boat trip around New York Harbor had to leave before the movies were over in order to catch the New York Central Railroad passenger ferry boat, which left the foot of West 42d Street at 11:30 a.m. This trip allowed time for many friendly and leisurely visits among groups of members and gave a fine opportunity to view transatlantic liner piers, which for the first time in years are busy with war work. A loud-speaker system explained the points of interest going up the east side of the river to George Washington Bridge and returning on the west side, passing down the bay to the Narrows. The return trip gave views of the busy Brooklyn waterfronts, the Navy Yard, and the east river bridges. Members left their cameras home in accordance with instructions. On this trip a box lunch was served, and the informality and restfulness of the trip were enjoyed by all after the busy days that had preceded. Friday evening there were dinners and get-togethers of alumni from Brown, Columbia, Dartmouth, and other colleges and universities.

The motor trip started Saturday morning at 9 a.m. at the Engineering Societies Building. It proceeded down the West Side Highway from the Lincoln Tunnel entrance, past the Holland Tunnel entrance, to the construction work on the entrance shaft of the proposed Brooklyn-Battery Tunnel. Passing along the East Side Highway, the party went through the Queens Midtown tunnel to Queens and continued on the East Side Highway, as far as the Triborough Bridge. Randall's Island was visited and after that the route followed the Major Deegan Boulevard to the 178th Street Tunnel entrance to the George Washington Bridge and across to New Jersey and return. This comprehensive circuit of Manhattan Island, with brief visits to New Jersey and Queens, gave out-of-town visitors as well as natives an excellent opportunity to see the buildings, bridges, and tunnels of New York City.

With these trips the Eighty-Ninth Annual Meeting came to a close. Much credit for its success should go to the various committees who arranged the multitudinous details and who were responsible for the smooth running of all the various events.

Making Your Service Available to the Government

THE WAR activities of our country will require a greatly augmented officer personnel. This increase will apply particularly to construction and related branches of the services requiring officers of technical training and experience. Except to graduates of R.O.T.C. units and officer candidate schools of our present Army, but few commissions have been issued or will probably be issued. Procedure of the War Department in augmenting commissioned officer personnel has been unofficially outlined:

(*a*) By ordering to active duty all present physically qualified Reserve Officers

(*b*) By commissioning all former officers, physically qualified, and

(*c*) As the Army is increased to 3,600,000, as announced on January 15, 1942, by issuing commissions to civilians, now without prior military training but needed as officers because of their professional experience.

In response to many inquiries from civil engineers who wish to make their services available to the Government, the following information is the current procedure.

ARMY COMMISSIONS

Those seeking commissions in the Army, including the Corps of Engineers, should send their professional records to the Commanding General of the Corps Area in which they reside. Do not address inquiries to Washington offices. There follows the address of the nine Corp Area Headquarters and the extent of the jurisdiction of each.

CORPS AREAS U.S. ARMY

First Corps Area, Boston Army Base, Boston, Mass.
Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island
Second Corps Area, Governors Island, New York
New York, New Jersey, Delaware
Third Corps Area, U.S. Postoffice and Customhouse, Baltimore, Md.
Pennsylvania, Maryland, Virginia
Fourth Corps Area, Post Office Bldg., Atlanta, Ga.
Tennessee, North Carolina, South Carolina, Louisiana, Mississippi, Alabama, Georgia, Florida
Fifth Corps Area, Fort Hayes, Columbus, Ohio
Indiana, Ohio, West Virginia, Kentucky
Sixth Corps Area, Post Office Bldg., Chicago, Ill.
Wisconsin, Michigan, Illinois
Seventh Corps Area, New Federal Bldg., Omaha, Nebr.
North Dakota, South Dakota, Minnesota, Nebraska, Iowa, Kansas, Missouri, Arkansas
Eighth Corps Area, Fort Sam Houston, San Antonio, Tex.
Colorado, Arizona, New Mexico, Oklahoma, Texas
Ninth Corps Area, Presidio of San Francisco, Calif.
Washington, Idaho, Montana, Wyoming, Oregon, California, Nevada, Utah

CIVILIAN EMPLOYMENT IN ARMY

There are opportunities in the U.S. Engineer Department for service in civilian status. Engineers in the U.S.E.D. are appointed from the Civil Service register or may be appointed temporarily by Executive Order through the District Engineer concerned. Inquiry should be to the District Engineer located nearest to you for forms for temporary engagement under Executive Order. It is here that specialists are needed. In addition to engineering abilities other expert abilities such as camouflage and photography can be utilized.

The Corps of Engineers operates on a decentralized basis with eleven Division offices, each having supervisory jurisdiction over a number of District offices. For convenient reference, the grouping and the addresses of the 11 Division and 57 District offices follow:

CORPS OF ENGINEERS U.S. ARMY

Office of Chief of Engineers, New War Department Bldg., Washington, D.C.
Arlington District, Arlington, Va.
Panama District, Panama, Canal Zone
St. Lawrence River District, Massena, N. Y.
Caribbean Division, 150 Broadway, New York, N. Y.
Bermuda District, York and Queen Sts., St. Georges (APO 802)
Jamaica District, 2B North St., Kingston (APO 804)
Puerto Rico District, San Juan
Trinidad District, U.S. District Engineer, Port of Spain
North Atlantic Division, 1216 Federal Office Bldg., 90 Church St., New York, N.Y.
Baltimore District, 332 Post Office Bldg.
Binghamton District, Security Mutual Life Insurance Bldg.
Boston District, 3rd Floor, Park Square Bldg., 31 St. James Ave.
Newfoundland District, U.S. Engineer Office, Fort Pepperrell, Newfoundland (APO 801D)
New York District, Room 420, 17 Battery Place
Philadelphia District, Room 900, Customhouse
Providence District, 819 Industrial Trust Bldg.
Washington District, 1st and Douglas Sts., N.W.
South Atlantic Division, Main and Laurel Sts., Richmond Va. (P.O. Box 1337)
Atlanta District
Charleston District, 33 Customhouse
Jacksonville District, 240 U.S. Courthouse & Post Office
Mobile District, 409 U.S. Courthouse & Customhouse
Norfolk District, 415 Post Office & Courthouse
Savannah District, Post Office Bldg.
Wilmington District, 308 Customhouse
Great Lakes Division, 419 Federal Bldg., Cleveland, Ohio
Buffalo District, 960 Ellicott Square Bldg.
Chicago District, 932 Post Office Bldg.
Detroit District, 613 Federal Bldg.
Duluth District, Engineering Bldg., Canal Park
Lake Survey District, 649 Federal Bldg., Detroit, Mich.
Milwaukee District, 408 Federal Bldg.
Upper Mississippi Valley Division, 829 U.S. Courthouse and Customhouse, St. Louis, Mo.
Rock Island District, Clock Tower Bldg.
St. Louis District, 816 U.S. Courthouse & Customhouse
St. Paul District, 1217 U.S. Post Office & Customhouse
Lower Mississippi Valley Division, Vicksburg, Miss. (P.O. Box 80)
Memphis District (P.O. Box 97)
New Orleans District, Foot of Prytania St.
Vicksburg District, U.S. Post Office and Courthouse
Missouri River Division, 1201 Davidson Bldg., 10 East 17th St., Kansas City, Mo.
Fort Peck District, Administration Bldg.
Kansas City District 601 Davidson Bldg., 10 East 17th St.
Omaha District, 1709 Jackson St.
Ohio River Division, 1420 Enquirer Bldg., Cincinnati, Ohio
Cincinnati District, 522 U.S. Post Office and Courthouse
Columbus District
Huntington District, Chesapeake & Ohio Bldg. (P.O. Box 2127)
Louisville District, 612 Federal Bldg. (P.O. Box 59)
Nashville District, 306 U.S. Courthouse
Pittsburgh District, 925 New Federal Bldg.
Wright Field District, Dayton,Ohio
North Pacific Division, 500 Pittock Block, W. 9th and Stark Sts., Portland, Ore. (includes Alaska)
Portland District, 628 Pittock Block, S.W. 10th Ave. and Washington St.
Seattle District, 700 Central Bldg., 800 Third Ave. (includes Alaska)
South Pacific Division, 1200 Balfour Bldg., 351 California St., San Francisco, Calif.
Honolulu District, Alexander Young Bldg.
Los Angeles District, Rooms 527-533, 751 South Figueroa St.
Sacramento District, 1209 Eighth St. (P.O. Box 1739)
Salt Lake City District
San Francisco District, 401 Customhouse
Southwestern Division, 16th Floor, Cotton Exchange Bldg., Dallas, Tex.
Caddoa District, Caddoa, Colo.
Denison District, Citizens National Bank Bldg.
Galveston District, U.S P.O., Customhouse & Courthouse (25th St. and Ave. F)
Little Rock District, Gay Bldg., 300 Broadway
San Antonio District
Tulsa District, 416 Wright Bldg.

UNITED STATES CIVIL SERVICE

Through Society cooperation, members of the Society have been sent questionnaires by the National Roster of Scientific and Specialized Personnel. Those who have not filed their qualifications with the National Roster are urged to do so. The roster is being used to assist the Army in assigning engineers and scientists to positions in which they are best qualified. Inquiries should be addressed to the Executive Director, National Roster of Scientific and Specialized Personnel, U.S. Civil Service, Washington, D.C.

The U.S. Civil Service is accepting applications for engineering positions of all kinds to fill the requirements of the Government's war effort. Unassembled examinations are made on the basis of applicants' record as shown on their application forms. Forms are available at any first-class or second-class post office; at the District offices of the Commission; and at the office of the Board of Civil Service Examiners in Washington, D.C.

Qualified sanitary and public health, highway, hydraulic, hydroelectric, irrigation, construction-estimating, and structural engineers are needed as Junior Engineers, Assistant Engineers, Associate Engineers, Engineers, Senior Engineers, Principal Engineers, and Head Engineers.

National Training Conference on Aerial Bombardment Protection

A TRAINING conference on the technical phases of Aerial Bombardment Protection will be held under the auspices of the Federal Office of Civilian Defense in cooperation with the U.S. Office of Education and the College of Engineering at New York University in New York City during the week beginning Monday, February 16, 1942. This conference is being arranged for approximately 50 civil engineering teachers from engineering colleges, and for 350 engineers and architects from public works and building departments of cities throughout the United States, from large industrial corporations, and from local sections of the American Society of Civil Engineers and the American Institute of Architects. The civil engineering teachers will have two additional days of discussions, and then, after the close of the national conference, will go to their own particular localities and institute similar training programs for local engineers and architects.

Lectures and discussions will be held morning, afternoon, and evening at the School of Education Auditorium, New York University, 35 West Fourth Street, New York, N.Y. The lectures will be presented by experts from the U.S. Army, Government departments, and universities. The opening session at 10 a.m., Monday, February 16, will be addressed by Major F. M. LaGuardia, Director of the Office of Civilian Defense.

The Office of Civilian Defense in Washington has requested the American Society of Civil Engineers to urge each Local Section to send a representative to this training course.

Sessions will be held morning, afternoon, and evening on the following schedule:

Monday, February 16—"Aerial Bombing," "New Factor in Engineering Planning and Construction," "High-Explosive, Incendiary, and Gas Bombs, and Their Characteristics," "Ballistics of Bombs, Penetration, and Perforation," and "The Explosion Sequence."

Tuesday—"Fundamentals of Structural Engineering," "Edgewood Arsenal Tests," and "Structural Materials and Design to Resist Direct Hits."

Wednesday—"Design of Wall Panels to Resist Blast," "Technical Lessons from London," "Pictures of Structural Damage from Bombing," and "Structural Behavior and Design Practice."

Thursday—"Protective Concealment," "Blackout Problems," "Stresses in Building Frames from Blasts and Effects of Side-Wall Hits," and "Reinforcing Existing Construction."

Friday—"Shelter Zones in Existing Structures," "Classification of Existing Structures," "Protection Against Incendiary Bombs," and "Transportation and Traffic Problems."

Saturday—"Design of Shelters," "Functional Requirements for Shelters," "Public Health Problems," "Subsurface Utilities," "Engineering Measures to Prevent Sabotage," "Policing Problems in Vulnerable Areas," and "Local Training Programs."

In addition, the sessions for engineering teachers, to follow, will include:

Monday, February 23—"Theoretical Aspects of Penetration Studies," "Vibration of Structures as Related to Explosion Effects," "Ricochet and Side-Wall Hits," and "Blast and Earth Shock Formulas."

Tuesday—"Air-Raid Shelter Requirements," "Future Structures for Industry, Commerce, and Housing," and "Forum on Local Training Programs in Air-Raid Protection."

Progress of J. Waldo Smith Fellowship—Air Removal at Summit of Pipe Line

SINCE last September Percy H. Bliss, Assoc. M. Am. Soc. C.E., present holder of the J. Waldo Smith Fellowship, has devoted all his time to studying the behavior of the air in the summit of pipe lines, under variations in pressure, discharge, slope, and time. His research has been conducted in the hydraulic laboratory of the State University of Iowa, at Iowa City. In a report dated December 29, 1941, he describes his progress as follows:

"Each group of experiments starts with conditions set so that no air whatsoever is removed from the pipe by the flowing water and ends when all of the air in the pipe is swept out almost instantly. Runs are made between these end points so as to obtain twenty to thirty intervals for the curves. Somewhere in the middle of these sets of experiments there occurs the critical condition where part of the bubbles flowing down the pipe collect to form one larger bubble that travels back upstream and blows back through the jump. This phenomenon was observed by Robertson [previous J. Waldo Smith Fellow].

"Early in the work it became apparent that time was an important variable. Consequently, many runs have been made lasting from three to six hours each, in which time was the only variable in addition to the rate of air removal. The progress of air removal was recorded at regular intervals of time during these runs to establish whether the rate changed with the decrease in the size of the confined air bubble or space.

"In September some runs were made on the laboratory set-up as left by Mr. Robertson. The gate that he had in the experimental section of the pipe line created a disturbance in the flow and also was not deemed as essential to the trend of the present investigations, so it was removed. A tee was substituted in place of the gate so that air could be admitted to the line in case it was necessary, and to eliminate the necessity of cutting a section of pipe. However, it worked out that the tee itself caused considerable irregularity in the water surface for the higher flows, and a second shutdown was necessary to remove it. By removing the tee, the portion of the pipe formerly between the summit and the tee became available for extending the length of the test section. One new 4-ft length of lucite pipe has also been added on the downstream end, thus in effect increasing the length of the test section by about 12 ft.

"The present laboratory set-up now consists of a straight pipe, in plan, having an upward slope of 45° to a summit, and a constant slope from the summit to the downstream end, this downstream slope being adjustable as desired. The vertical curve at the summit consists of a 45° elbow and wedge gasket for the small slopes. For the steeper slopes, segments of another elbow have been flanged as needed. The transparent lucite pipe extends about 4 ft down the approach slope and all the way down the outlet slope. This has as a prototype, therefore, a practical condition often encountered in the field, where a pipe goes up over a hill and down again. There are now no valves, tees, or other obstructions in the test section whatsoever.

"A shipment of smaller lucite pipe has been obtained by the laboratory so that if time permits, the effect of the size of pipe on these results on the present 6-in. pipe may be studied. At least it should be possible to ascertain whether the diameter of the pipe has any great effect upon the problem, although the testing of only two sizes would not constitute a thorough investigation of this variable.

"It is too early to make any conclusive statements from the results so far obtained, but by the end of June, when the present fellowship expires, it should be possible to shed some light on when air will be removed from the summits of pipe lines by the flowing water and when it will not; and also on the length of time it will take to remove a given amount of air from a pipe line with a given discharge and pipe slopes."

Progress of Society's Hydraulic Research

Eighth Annual Report of Special Committee

VALUABLE ADVANCES in hydraulic study have been made possible during 1941 through the activities of the Society's Special Committee on Hydraulic Research, as briefly reviewed here. Previous reports of the activities of this committee have appeared in the following issues of CIVIL ENGINEERING: March 1937, p. 195; March 1938, p. 194; February 1939, p. 109; March 1940, p. 185; and February 1941, p. 124.

One meeting was held during the year at the U.S. Waterways Experiment Station, Vicksburg, Miss. All members were present,

FIG. 1. LABORATORY EXPERIMENT ON SEDIMENTATION AT CONFLUENCE OF RIVERS

together with cooperating members F. M. Dawson and H. Rouse, and J. W. Robinson representing A. A. Kalinske.

1. Letter Symbols for Hydraulics

The standard list of symbols for hydraulics has been revised as of 1941 and has been approved by the steering committee. The list is now up for final adoption by the American Standards Association. The list has also been adopted by this committee.

2. Conformity of Model to Prototype

A symposium on this subject is being assembled preparatory to its publication in PROCEEDINGS at an early date. This symposium will include some new and valuable papers.

3. Research Projects

The following are being carried on under the general direction of the committee, aided with funds provided by the Engineering Foundation and the institutions concerned:

Project 67-a. Conversion of Kinetic to Potential Energy, by F. T. Mavis and A. A. Kalinske at the University of Iowa. The laboratory work for this project was completed during the current year and preparation of the final report is under way. The principal research has been with expanding conduits. Expansions having total angles of $7^1/_2$, 15, 30, and 180 degrees have been subjects of experimentation. Velocities have been determined by motion pictures, which entailed a great deal of analytical work to obtain the final results in statistical form. An inkling of some of the fine things that will appear in this report may be gathered from the paper by Prof. Kalinske, "Relation of the Statistical Theory of Turbulence to Hydraulics" (TRANSACTIONS, Vol. 105, 1940, p. 1547). In this paper a very few of the data gathered were used to illustrate some features of the turbulence theory presented.

Project 67-b. Traveling Waves on Steep Slopes, Harold A. Thomas, Carnegie Institute of Technology, Pittsburgh, Pa. The laboratory and field work on this project has been completed and the preparation of the final report is under way. However, it has been delayed owing to the illness of Prof. Thomas. When this paper appears the profession will have a much clearer insight into the phenomena of waves and particularly the waves that follow in a train down a steep slope.

Project 67-c. Phenomena of Intersecting Streams, Morough P. O'Brien, University of California, Berkeley. The first part of this research project has been completed and the results presented in the form of a thesis. This part dealt with open conduits entirely. No conclusive results were determined except that the number of variables was too great and that further research should be made with closed conduits before again undertaking studies in open channels. At present experimental work is under way in connection with a closed chamber in which parallel currents are mixed and the phenomenon of this mixing determined experimentally.

Project 67-d. Curves in Open Channels, C. A. Mockmore, Oregon State College. The first draft of this paper was completed some time ago and sent out to a goodly number of engineers. From the comments received the report is being revised and will be available before long. It will present the results of laboratory experiments and their comparison with a mathematical analysis. The preparation of the final paper is well under way.

Project 67-e. Sedimentation at the Confluence of Rivers, L. G. Straub, University of Minnesota. Laboratory experimental work concerned with the sedimentation at the confluence of rivers is being compared with a limited amount of field data obtained on river confluences. The experimental work during the past year has been with complete freedom of behavior of the river confluences, that is, without rigid wall restrictions to the flow of water. The tributary stream and the main stream were directed into the common channel with definite angles of approach, but at the entrance to the common channel there was no wall restriction outside of the sand itself. The experiments point out definite natural tendencies of the stream at the point of confluence, depending upon the relative amount of sedimentary load carried along the stream bed by the approaching rivers. Experiments were performed at the St. Anthony Falls Hydraulic Laboratory. A report on this project is being prepared. Moving pictures were made in the course of experiments. See Fig. 1.

Project 67-f. Studies of Air Resistance to Flow of Water in Open Channels, L. G. Straub, University of Minnesota. Experimental apparatus for the observation of entrainment of air occurring in water flowing at high velocities with a free surface has been arranged in the St. Anthony Falls Hydraulic Laboratory, to take water directly from the upper pool of the Mississippi above St. Anthony Falls. The channel proper is approximately 47 ft long, 12 in. wide, and 10 in. deep. Experiments thus far have been with slopes up to 12 degrees and velocities up to 22 ft per sec. Three different channel roughnesses have been used, including: (1) a smooth steel surface, (2) standard Ottawa sand, and (3) sand of coarseness between 12 and 16 U.S. sieve series. Moving pictures of the flow conditions have been made at speeds up to 128 frames per sec. High-speed photographs at approximately $^1/_{100,000}$ sec exposure have also been made. Paralleling the laboratory studies, observations have been made of the flow phenomena on steep chutes on the river immediately adjoining the laboratory. See Figs. 2 and 3 for views of these experiments.

FIG. 2. STUDY OF ENTRAINMENT OF AIR AND TRAIN-WAVE FORMATION ON CHUTE AT ST. ANTHONY FALLS

Project 67-g. Simultaneous Flow of Air and Water in Closed Conduits, F. M. Dawson, University of Iowa. During the past year tests were completed on the 50-ft rectangular conduit 8 in. wide and 7 in. deep. Materials were purchased and designs completed for increasing the depth of this conduit to about 15 in. Tests have been completed on the present channel placed at a very low slope, at a slope very near the critical (as determined from the velocity of a gravity wave), and at slopes considerably greater than the critical. For each of these slopes series of runs were made at three or four rates of water flow. For each rate the variation in the depth of flow with the rate of air flow was studied. In the case of the two flatter slopes, the depth of water was always kept uniform by means of an adjustable tailgate. For the steeper slopes the flow could not be kept uniform but the depth did not vary greatly.

The results are being analyzed and plottings so far indicate a very interesting correlation between air rate, depth of flow, and water discharge. Calculations are now in progress in order to obtain the drag at the air-water interface. Another phase of this project is concerned with the hydraulic and pneumatic conditions when water enters vertical pipes under low heads, with the result that air is drawn into the pipes and the pipes do not flow full. This phase has been in immediate charge of J. W. Robinson.

Project 67-h. Critical Depth Weirs, C. A. Wright, Polytechnic Institute of Brooklyn. Work on this project so far has been limited to the study of the flow over a wooden model critical-depth meter. Additional research helpers have now become interested in this project and further progress is looked for.

Project 67-i. Nature of Hydraulic Friction, Boris Bakhmeteff, Columbia University. This subject is one of the oldest in engineering, yet it is far from being satisfactorily solved. Recent theories regarding turbulence have presented this subject in a different light from that heretofore considered. The old empirical approach has given way to a more rational one based on a more rigid analysis of fundamentals.

At San Gabriel Dam No. 1 there is a unique opportunity to obtain data on the friction characteristics in large pipe lines under very high velocity where the Reynolds number exponent is 7, and perhaps 8. Reference is made to the article, "San Gabriel Dam No. 1," by Paul Baumann (PROCEEDINGS, September 1941), and particularly to the outlet works, page 1225. Through the good offices of the Los Angeles County Flood Control District, of which H. E. Hedger is chief engineer, and Paul Baumann, assistant chief engineer, facilities have been installed in the 51-in. outlet pipe to determine with great accuracy the velocity distribution in the pipe on two sections at right angles to each other. The Fuller tube will be used, in which a hypodermic needle forms the orifice. The pressure at the point of the needle is balanced by an inert gas whose pressure is measured with considerable accuracy. This tube was developed by Edwin S. Fuller, engineer with the Los Angeles Flood Control District.

By this method it is expected to determine the velocity distribution in very small increments from the boundary of the tube inward to the center along two diameters. Velocities may reach as high as 50 or 60 ft per sec.

After the experimental work in the 51-in. tube has been completed it is contemplated to benefit by the experience there gained and obtain similar data in the 123-in. outlet pipe. A most interesting comparison of velocity distribution as here observed and as calculated by the log formula presented by Von Kármán is anticipated.

FIG. 3. PROFILE OF HIGH-VELOCITY FLOW IN TEST CHANNEL SHOWING AIR ENTRAINMENT—EXPOSURE AT ABOUT $^{1}/_{100}$ SEC

Project 67-k. Supercritical Velocity in Open-Channel Transitions, Hunter Rouse, University of Iowa. Work on this project began in October 1941 as soon as funds from the Engineering Foundation were available. Waters emerging from a channel and debauching onto a plain surface pass through the Belanger critical flow condition and assume certain characteristic forms, including waves, of which very little is known as yet. By placing various types of boundaries along the margin of the outflowing water on the plain surface it is hoped to arrive at authentic information regarding the phenomena of waves under such circumstances. The practical aspects of this project will appear in the form of more rational design of transition sections between conduits of varying velocity magnitudes.

4. Manual on Hydraulic Models

This work has been completed and the final manuscript has been transmitted to the Committee on Publications with the request that it appear in the form of a Society manual. Requests have been made that the budget contain an item covering publication in the year 1942.

Respectfully submitted,
J. C. STEVENS, *Chairman*
CHILTON A. WRIGHT, *Secretary*

December 1, 1941

Sanitary and Public Health Maintenance in War Time

Society Committee Recommends Protective and Remedial Measures for Public Works

How can civil engineers be constructively helpful in promoting the national war effort? Such a question might naturally be addressed to the Society, as the operating power house of a profession vitally important in the war effort. As a matter of fact, the Society has already taken steps in a number of ways, perhaps not at once obvious to its members.

For example, the Society aided in the National Roster of Scientific and Specialized Personnel compiled in 1941, by collecting data and transmitting it to the Federal Government for its use. This Roster had been of considerable value already, and doubtless will be of increasing importance as the war progresses. Another effort was under the auspices of the Highway Division; the Manual of Engineering Practice No. 23, on "Military Roads in Forward Areas," was issued to the members in 1941. The Society furnished complimentary copies of this Manual to the War Department for the use of the Corps of Engineers.

High on the list of Society efforts in 1942 will be the first sectional report of the Committee on Civilian Protection in War Time. The several sections of this national group, collaborating with the Federal Government through the National Civil Protection Committee, will present bulletins from time to time. The first, by Samuel A. Greeley, M. Am. Soc. C.E., appeared in the January issue of PROCEEDINGS. It deals with the steps to be taken for the maintenance of sanitary and public health engineering services in war time.

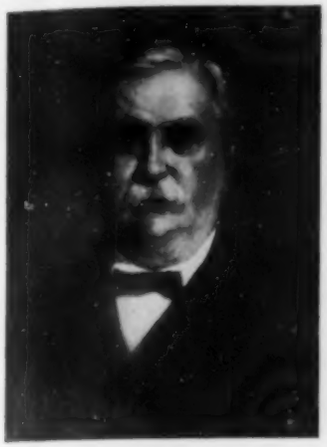
With this report as a guide, no engineer in public service will have an excuse for unpreparedness in emergencies. It relates to water supply, sewerage, refuse disposal, street cleaning, public comfort stations, milk supplies, rooming houses, and restaurants. Factual as it is, however, the report is offered as a target, inviting constructive criticism by qualified engineers, with the expectation that successive reports will become better and better until, eventually perhaps, a manual or a final report on this subject will emerge for the guidance of civil engineers in the national emergency.

Doubtless many engineers will find it convenient to possess this report in pamphlet form. Single or multiple copies, in cardboard covers, may be obtained at the rate of 10 cents per copy, by ordering directly from Headquarters.

Alfred Noble Prize to Electrical Engineer

THIS year the Alfred Noble Prize will go to Robert F. Hayes, Jr., for his paper entitled "Development of the Glow Switch," which was published in the May 1941 issue of *Electrical Engineering*. The presentation will take place on January 28 at the winter convention of the American Institute of Electrical Engineers, of which Mr. Hays is an associate member.

The prize goes annually to a member of one of the Four Founder Societies or the Western Society of Engineers for a published technical paper of exceptional merit. The author of the paper must not have passed his thirty-first birthday. A joint committee of five members, representing the five engineering societies just mentioned, is in charge of selecting the recipient after careful consideration of the several papers submitted to it by special subcommittees of these societies.



ALFRED NOBLE

Ability and opportunity have made it possible for Mr. Hays to make a most outstanding technical and engineering contribution to the electrical art in the field of illumination. The glow switch, the most satisfactory device yet perfected for the operation of the modern fluorescent lamp, was invented by E. C. Dench, of the Westinghouse Electric and Manufacturing Company. Mr. Hays, although assisted by other engineers of the company, was responsible for the adaptation of the switch to quantity production and for its development for general use. The importance of this development is attested by the fact that over ten million of these devices are now in use. Mr. Hays' work thus represents an outstanding contribution by one of the younger members of the profession.

Born in 1914, he is well under the age limit established by the Prize conditions. After graduation from Mississippi State College in 1935 with the B.S. degree in electrical engineering, Mr. Hays was employed in various activities—operation of electrical equipment, engineering draftsman, and instructor in physics at his alma mater. In 1938, he became a development engineer with the Lamp Division of the Westinghouse Electric and Manufacturing Company at Bloomfield, N.J.

The Alfred Noble Prize was established in 1929 through a fund contributed by engineering and other friends of Alfred Noble, one time President of the American Society of Civil Engineers, the American Institute of Consulting Engineers, and the Western Society of Engineers.

A pioneer product of the Middle West, Alfred Noble was born in Michigan in 1844—a time when the pioneer state was being settled. He served in the Civil War, earned enough money to put himself through the University of Michigan, and worked on the survey of the Great Lakes. Then, for nine years, he gave his undivided attention to a work which was to claim his interest and attention throughout his life—the Sault Sainte Marie Canal construction, the first truly modern undertaking of the kind in America. He was also a bridge builder, having worked on the Red River Bridge in 1882, the Washington Bridge in New York in 1886, Morison's great bridge at Cairo, and on the remarkable Memphis cantilever in 1889. His hydraulic activities included work on the Chicago Drainage Canal, and he served as consultant on the Isthmian Canal Commission, the Welland Canal in Canada, and the New York State Barge Canal. His final work was one of the most comprehensive and daring projects ever attempted, the building of the Pennsylvania Railroad tunnels into and under New York. In 1914, in the midst of this great undertaking, he died.

In the main hall of the Engineering Societies Building, a memorial tablet to Alfred Noble, unveiled in 1922 by the American Institute of Consulting Engineers, commemorates his achievements in the following inscription: "An Upright Man, a Good Citizen, an Eminent Engineer, Whose Life and Labors Contributed Greatly to the High Honor of His Profession and to the Success of Many Important Public Works."

In awarding the Noble Prize for 1940–1941 to Mr. Hays, the committee hopes that he will keep fresh in his memory the life and character of the great engineer whose name it perpetuates, and that the award may serve to encourage him to make further contributions to the progress of the engineering profession.

Final Ballot on Society Officers for 1941

To the Eighty-Ninth Annual Meeting *January 14, 1942*
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1942 report as follows:

For President

Ernest Bateman Black	3,999
Scattering	8
Blank	0
	4,007

For Vice-Presidents

Zone I:

Charles Milton Spofford	3,972
Scattering	12
Blank	23
	4,007

Zone IV:

Thomas Elwood Stanton	3,970
Scattering	11
Blank	26
	4,007

For Directors

District 1 (two to be elected):

Van Tuyl Boughton	3,978
George William Burpee	3,984
Scattering	6
Blank	46
Total votes registered	8,014
Total ballots canvassed	4,007

District 4:

Scott Barrett Lilly	3,992
Scattering	1
Blank	14
	4,007

District 11:

A. M. Rawn	3,992
Scattering	2
Blank	13
	4,007

District 14:

William Dewoody Dickinson	3,987
Scattering	3
Blank	17
	4,007

District 15:

John Thomas Lamar McNew	3,992
Scattering	2
Blank	13
	4,007

Ballots canvassed		4,007
Ballots withheld from canvass:		
From members in arrears of dues	17	
Without signature	68	
Total withheld		85
Total number of ballots received		4,092

Respectfully submitted,
HARRY T. IMMERMAN, *Chairman*

Charles D. Thomas, Ronald B. Dillenbeck, William H. Dieck
James McKeegan, Frank L. Greenfield, Arthur S. Pearson
Howard Holbrook, Geert Blaauw
Tellers

Protection Against Aerial Bombing

Recommendations of Committee on Civilian Protection in War Time, Metropolitan Section of the Society

THE following recommendations have been prepared by the Committee on Civilian Protection in War Time, Metropolitan Section, American Society of Civil Engineers, in order to help individuals find those places which offer a measure of safety in the event of aerial attack. The recommendations must be considered only as general guides, because actually every building is a separate problem. The detailed selection of shelter zones is a task for the expert structural or architectural engineer who has a thorough knowledge of the effects of bombs on materials and structures.

1. *No place is safe against a direct hit of a heavy bomb.* You will have to take chances on that wherever you are. You may take comfort from the fact, however, that the chances of a direct hit on any one person are very small.

The number of deaths and injuries from a direct hit will be minimized if you do not assemble in large crowds. Break up into small groups in separate rooms or corridors. Long corridors may be divided with sandbag barricades at intervals, with small passageways, to provide a series of compartments. There are many places which offer protection against blast, fragments of glass, and bomb splinters, but they must be carefully studied and marked as soon as possible.

In all towns there are buildings with skeleton construction, which are fireproof and may be available as refuges. An engineering survey should be made by the authorities to determine the location of such buildings, and proper provision made for their use. There are many other buildings that will offer some safety in an emergency.

2. *If you are in your own home* and it is a one- or two-story wood-frame building, and the enemy is dropping high-explosive bombs, the best place is in the basement. The walls of wood-frame buildings are easily burst by high-explosive shell fragments. If incendiaries or gas bombs are being dropped, the best place is on the floor under a table on the second floor level. In selecting the second floor zones, however, avoid areas beneath unfloored parts of the attic.

If your house has solid brick or stone walls for all stories (not brick veneer), rooms on the first or second floor offer comparative safety against fragments. Keep in mind, however, that some fragments have actually perforated solid walls of brick or reinforced concrete 12 in. thick. Stay away from windows and areas in line with windows. Serious injuries have been caused in England by flying glass.

If you have a narrow basement corridor, stay there, but not near the furnace. Be sure, however, that there is a window or exit which will offer a means of escape if the building collapses.

If an ordinary residence gets a direct hit, or is close to an outside hit, it is quite certain to collapse. If you are in the first or second stories, there is little chance of escape. There is a better chance of escape if you are in a basement corridor, because the ceiling beams will support a debris load from above.

If there are no corridors in the basement, and it is entirely open except for one or two small interior columns, then there is no place safe against a direct hit. A small section of the basement near an exit many, however, be reinforced with temporary columns and beams to provide against being trapped by debris from the stories above.

WHAT HAPPENED TO A REINFORCED CONCRETE BUILDING IN SWATOW, CHINA, BOMBED BY JAPANESE

3. *If you are in an apartment house six stories or less in height,* the building is probably what is termed a "wall-bearing" structure. In general, it is not fireproof. Timber floors are supported on outside walls and partition walls. There may be a few inside steel columns with a few steel beams helping to carry the load, but the building is nevertheless essentially wall-bearing in nature, and under a heavy blast or direct hit it may collapse in one huge pile of debris. Some of these buildings, however, have heavy cross walls which may confine the collapse to a portion of the structure.

WALL-BEARING STRUCTURES WITH TIMBER FLOORS, BELGIUM
Shelter Zones in Basement Corridors, With Exits, Would Offer Chance of Escape

Do not remain on any of the upper floors unless you are sure there are interior steel columns and beams that will tend to keep the interior rooms and halls from collapsing. If such is the case, some safety will be found in such interior zones.

Many of these apartment buildings have solid brick walls in the basement, and if there is a narrow corridor, go to that, but stay away from the boiler room. You will then be safe from fragments; if the building collapses you have a chance of escaping because the roof over the narrow corridor will carry a heavy debris load. Be sure, however, that there is an emergency exit to avoid being trapped. Basements without narrow corridors may be reinforced with temporary struts and beams to support debris loads from above. The majority of English shelters in existing buildings are located in basements, many of which have been reinforced.

There are many apartment houses around military objectives in many cities. Owners should keep in mind, however, that every building is a problem in itself and should be investigated by an expert structural engineer or architectural engineer who can pass judgment on structural safety and who is familiar with the effects of bombs.

4. *If you are in an apartment house more than six stories high,* it is probably a fireproof structure with a separate steel or reinforced concrete frame and concrete floors. It will probably survive even a direct hit, although terrific damage will be done to walls and floors.

In these buildings, go to interior rooms or hallways on any floor above the first and preferably above the second. If there are no interior rooms, stay away from windows. Also stay away from the top story. Incendiary bombs may penetrate into the top story. It must be remembered, however, that a heavy bomb may go almost any place in the building. It can penetrate the side wall as well as the roof. It may consequently explode at almost any point in the interior. You will have to take chances on a direct hit.

Basement zones away from boiler rooms in this type of fireproof apartment building with a separate structural frame are recommended for shelters.

5. *If you are in a school house and it is an old building two or three stories in height,* it is probably wall-bearing and absolutely unsafe. School children should be kept out of such buildings unless

PICTURES FROM ENGLAND CARRY LESSONS FOR AMERICAN ENGINEERS—ALL VIEWS BY COURTESY OF O. BONDY, CONSULTING ENGINEER, LONDON

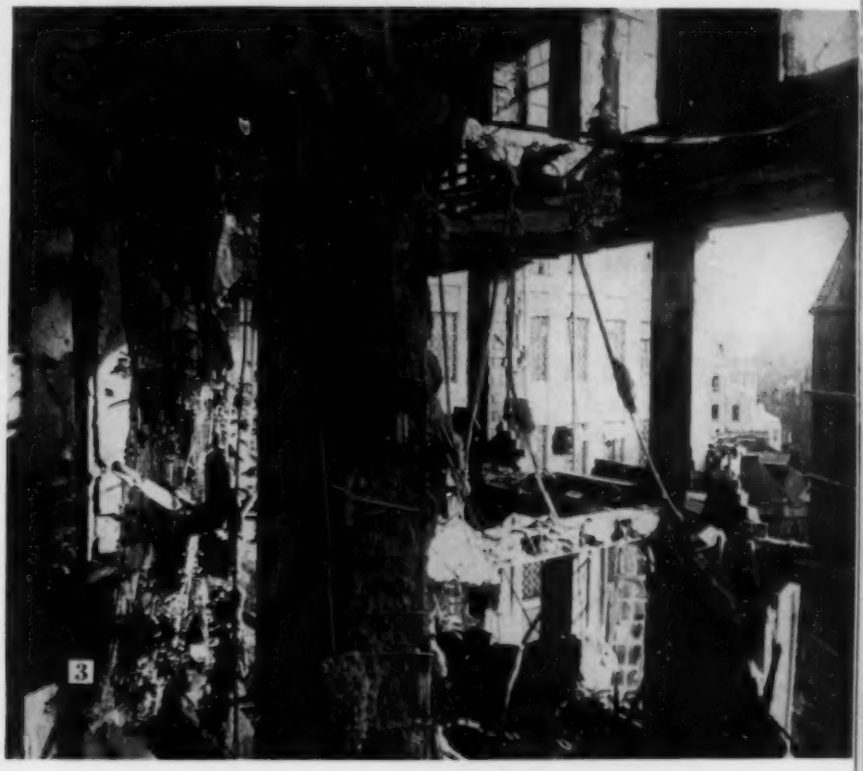
1 DIRECT HIT CAUSES A COMPLETE COLLAPSE, WITH FIRE. REINFORCED BASEMENT ZONE, WITH EMERGENCY EXITS, WOULD PERMIT ESCAPE

STRUCTURAL FAILURE—THE DESTRUCTION OF SUPPORTS HAS CAUSED PARTIAL COLLAPSE

DAMAGE TO FLOORS, PARTITIONS, AND WALLS OF A MODERN LONDON BUILDING, DUE TO AN INSIDE EXPLOSION.

WRECKAGE OF A SUBSTANTIAL BUILDING IN AVE MARIA LANE, LONDON

RESULTS OF A SIDEWALK HIT ON A MODERN STEEL-FRAME BUILDING—SAME BUILDING AS (3).



nearby shelters are available or the basements are reinforced.

If it is a modern school building, however, it is probably fireproof with an independent steel or reinforced concrete skeleton frame. If so, it offers much more protection in general than neighboring homes and apartments, and school children should be assembled in interior rooms or corridors on the second floor and floors above, but not on the top floor. Keep in mind the principle of dispersion into small groups. There will probably be recommended shelters in the basement away from boiler rooms. Make certain that there are exits available from basement zones.

Most school buildings have large window areas and glazing along corridors. Flying glass is very dangerous. Keep away from glazed areas.

Many modern school buildings have steel frames, but they are only two or three stories in height. Recommended shelters in such buildings should be located on the second floor and in the basement. Even the top floor offers considerable protection if the roof is thick enough to resist incendiary bombs.

All school buildings should be classified immediately by the responsible authorities.

6. *If you are in an old store building two or three stories in height*, (and there are many such structures) you are in a building that is generally quite unsafe. There may be narrow basement corridors, however, with exits, that will provide a measure of safety.

Many old store buildings, however, have solid brick walls, and are shielded by buildings on either side. Hence there may be recommended shelters on the first floor, but one should avoid the front part of the store with its shop windows opening onto the street. Again it needs to be emphasized that every building is a separate problem.

If you are in a modern store building with a number of stories, go to interior areas on the second floor or above. These buildings will generally have steel frames, and although a direct hit will penetrate them, the building as a whole will not collapse.

7. *If you are in a skyscraper building*, it is a fireproof structure with a steel frame. It is a very strong building, and in general all interior corridors and rooms above the second floor offer considerable protection.

There will also be recommended shelters in the basements. Foundation walls are often of heavy construction. Avoid vicinity of boiler rooms, however, and do not overlook the possibility of gas accumulation. Many basement rooms, however, are well ventilated. An outside explosion may fracture a water main and crack the outside foundation wall, causing flooding in basements unless pumping facilities have been provided.

Vacate outside offices. Do not go to interior zones which are one or two stories directly beneath setback roofs. Stay away from the upper six stories. There is more danger here because of the possibility of elevator machinery crashing down into interior halls near the elevator shafts.

Avoid that portion of the corridors immediately adjacent to elevator doors.

Interior stairways offer some safety if the roof bulkhead is strong.

8. *If you are in a movie theater*, and the air-raid siren sounds, it is advisable to leave immediately, unless the building is a recommended shelter, or unless the raid is actually on. Every theater is a special problem. Theaters should be classified by the authorities so that audiences may know whether they are in a good, a medium, or a poor air-raid shelter.

The small neighborhood movie theaters are apt to be of non-fireproof construction and if so, are poor shelters. On the other hand, there are a number of modern theaters in steel-framed buildings which offer considerable protection, and it is better to stay there than to go out into the streets. During air raids, however, people should stay away from portions of such theaters near outside walls. Interior lobbies and corridors will offer good shelter.

9. *If you are in a one-story factory devoted to defense production*, stay on the job and take your chances unless the factory owners have provided basement shelters immediately adjacent to your work. Workmen should stay away from outside walls, however, during an air raid, unless there is a solid brick or masonry wall capable of resisting bomb fragments.

If you are in a factory building of several stories, and it is an old structure of wall-bearing construction, upper floors should be vacated. If it has a reinforced concrete or steel frame, it is not likely to collapse and interior zones are fairly safe. Many factories, however, have large open areas which should be broken up by sandbag barricades or blast walls in order to minimize the injury and destruction which might be caused by a direct hit.

Every industrial building is a problem in itself. The framing, the layout, the equipment, and the type of construction must be studied in order to get the best locations for shelter zones.

10. *If you are in the subway*, stay there. Do not go up into the streets. The roofs of subways are extremely strong. They will not resist direct hits, but will support a large debris load. Moreover the subways offer safety against blast and fragmentation.

On the other hand, there is the danger of flooding and electrocution from power cables. But there are many zones in subways which are recommended as shelters and should be so marked immediately.

11. *If you are in the street*, follow the directions of an air-raid warden, if available. Unless the individual is near some refuge provided by public authorities, however, he must choose a place which offers the best protection. Subways will offer shelter and, in many areas, are the most convenient refuge. Fireproof buildings, above and below the first story are excellent, but center corridors of first stories, and even inside rooms of non-fireproof buildings or doorways will give protection in urgent cases. These recommendations apply to individuals caught on city, town, or village streets.

Again it must be emphasized that the preceding recommendations are general guides which if followed will tend to minimize injury and loss of life. Every building, however, is a problem in itself, and the intelligent classification and marking of shelter zones in that building in accordance with a uniform plan is a problem calling for the advice of expert engineers who are thoroughly familiar with building construction and with the effects of aerial bombs on structures of all types.

COMMITTEE ON CIVILIAN PROTECTION IN WAR TIME, METROPOLITAN SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS

Harold E. Wessman, *Chairman*
Chester L. Dalzell, *Secretary*
George W. Burpee
John C. Riedel
E. M. Van Norden
S. G. Hess
E. E. Seelye
Billings Wilson

Second Question on Engineering Economics

LAST month the Executive Committee of the Engineering Economics Division inaugurated a series of questions on current problems involving the principles of engineering economics. It is hoped that these topics will prove of interest, and replies, of not over 250 words in length, are solicited from members of the Society. All letters should reach the Secretary of the Division (J. H. Porter, 1204 Landreth Bldg., St. Louis, Mo.) by the 25th of the month in which the question appears, in order that extracts from the most informative of these may be printed in the second issue of CIVIL ENGINEERING following.

The second subject for discussion is:

> *"How may the social gains anticipated as a result of the construction of an engineering project be evaluated in engineering terms?"*

First War Casualty Among Society Members

NEWS has been received from Manila of the death of George D. Cowie, M. Am. Soc. C.E., in an air raid there on December 24. This seems to be the first fatality of a Society member due to American participation in the war. Curiously enough, although Commander Cowie saw extensive military service in the last war, he was on civilian duty for the U.S. Coast and Geodetic Survey when he was killed. In fact he was in his office, at work, when the bomb came. A brief obituary appears elsewhere in this issue.

This tragedy is but another instance of the engineer's active participation in the nation's struggle. Wherever danger lurks, there the engineer is to be found fulfilling his duties, which are of vital importance to the war effort. The sympathy of all Society members goes out to Commander Cowie's family, and their most vigorous encouragement to all other members who are serving on our far-flung battle front.

Recommendations on Conservation of Steel

One of the joint activities connected with the present national emergency is the Engineers' Defense Board. The Society is officially cooperating with this Board. Among other matters dealt with by the Board is the economical use of steel. Through a subcommittee, it has made recommendations on this subject in response to the specific inquiry of H. LeRoy Whitney, Chief, Technical and Engineering Section, Iron and Steel Branch of the OPM in Washington. The Board's recommendations to Mr. Whitney were made by a committee, all of whom are members of the Society; and were submitted under date of December 8. They are now made available for release. The following letter, addressed to Mr. Whitney, explains the details of his request and the Board's recommendations:

Under date of November 19, you wrote to Mr. Carlton S. Proctor, Chairman of the Committee on Steel Conservation and Reclamation of the Engineers' Defense Board, asking counsel on the following matters:

(1) Advice on the recommendations made by Mr. Harry Diamond of the Elizabeth Iron Works to use scrap ends of wide-flange beams in place of column base plates.

(2) Recommendations for clauses to be included in all Government contracts and recommended for all private contracts having to do with the salvaging of all scrap steel on the job, such as sheet piling, etc., and also recommendations on any method of conserving steel in its present uses as well as the reclamation of steel for scrap.

(3) Recommendations as to design stresses in structures designed by Army and Navy, particularly reinforced concrete.

(4) Recommendations as to maximum roof and crane way spans.

In addition to questions asked in your letter, Mr. Proctor's committee has considered the matter of recommendations as to a manual for the period of the emergency which, it is hoped, will be acceptable to many municipalities and political subdivisions in permitting types of construction and materials, working stresses and live loads, which will reduce to a safe minimum the amount of steel used in building, etc.

In response to your request, the Engineers' Defense Board herewith submits the following report, based on the recommendations of Mr. Proctor's committee, consisting of Messrs. Carlton S. Proctor, chairman; Rene L. Bertin, Richard E. Dougherty, Charles F. Goodrich, Shortridge Hardesty, and J. P. H. Perry:

On the matter of your request for advice as to recommendations of Mr. Harry Diamond of the Elizabeth Iron Works, it is the Board's opinion that the shortage of steel-industry capacity to produce plates is acute, and that Mr. Diamond's scheme for using scrap ends of wide-flange beams for base plates is workable and practicable. It should be borne in mind, however, that this is only one of many possible schemes which might be used for substituting structural shapes for plates, such as the use of steel grillages, etc. Much could undoubtedly be accomplished in the saving of plates if the OPM were to issue a request to designers and users of structural steel that they substitute steel shapes for plates wherever possible.

In answer to your question as to clauses to be included in all Government contracts and recommended for all private contracts having to do with the salvaging of scrap steel, the following provision is recommended:

That Federal specifications be immediately amended to provide that where Federal construction includes the use in temporary construction of such materials as steel sheet piling, framing, bracing, forms, etc., which may be reclamable but which are not normally reclaimed because of the cost of reclamation exceeding the salvage value, such materials shall be reclaimed for either re-use or salvage as scrap.

Also, that on private construction operations similar reclamation of recoverable essential products be requested.

Also, that a general request be issued, or governmental project initiated, whereby abandoned buildings, tracks, and other facilities containing any substantial amount of steel or other metals suitable for re-use or for scrap be demolished and such steel or other metals reclaimed.

As to your request for recommendations as to design stresses in structures, particularly reinforced concrete structures, and as to Mr. Proctor's suggestion that the appropriate governmental agency or agencies urge the adoption of an emergency manual by municipalities and political subdivisions, in order to liberalize types of construction and materials, working stresses, etc., to affect material reductions in quantities of steel used, the Board recommends as follows:

1) Reinforced concrete design stresses used on emergency structures should conform to the latest New York City Building Code requirements, which permit the following tensile unit stresses in reinforcing steel:

Structural grade billet steel	18,000 lb per sq in.
Intermediate grade billet steel	20,000 lb per sq in.
Steel with yield point in excess of 50,000 lb per sq in., 40% of the yield point but not to exceed	24,000 lb per sq in.

2) The Board recommends that a manual be prepared within the shortest possible time by representatives of such national organizations as the American Standards Association, governmental departments, particularly the Army and Navy, steel, concrete, and lumber institutes, representatives of engineering societies, and of the fire underwriters. This manual should be made applicable to all structures needed for the national emergency, bearing in mind that many will be of a temporary nature.

In order to accomplish the purposes of such a manual, namely, to conserve critical materials, it should:

1. Liberalize working stresses.
2. Reduce live loads for which structures are proportioned, to actual safe maximum conditions.
3. Encourage the use of plain masonry wherever possible, as in footings, retaining walls, and the like.
4. Liberalize the use of wood for the construction of roofs and roof structures.
5. Discourage, and in some cases, prohibit the use of steel for the construction of items where less critical materials such as wood, plastics, concrete, and gypsum can be used instead, for instance:
   - (*a*) Steel pipe piles and sheet piling
   - (*b*) Steel floors
   - (*c*) Window sash and doors
   - (*d*) Partitions
   - (*e*) Steel guards at platform edges and column corners, railings, and fencing
   - (*f*) Sheet metal flashings
   - (*g*) Marquise
   - (*h*) Flag poles
   - (*i*) Metal furniture
6. Particularly where the construction is of a non-permanent nature, liberalize the plumbing, electrical, and fire protection regulations.
7. Revise zoning restrictions if necessary, in order that they may operate within the intent of this proposed emergency period manual.
8. Encourage the development of concrete road construction using reduced steel reinforcement.

In order to make such a manual effective, it should be distributed by the OPM to:

- (*a*) The city officials of every city in the United States having a population of 10,000 or more
- (*b*) All state and federal agencies concerned with construction
- (*c*) All licensed architects and engineers
- (*d*) All members of engineering societies
- (*e*) Such other groups as are directly or otherwise connected with construction, such as engineering schools and colleges, money lending institutions, etc.

In the draft of this manual, the most recently adopted building codes should be secured and reviewed, with the view of adopting the desirable features found therein. Such provisions as those stipulated for the construction of the temporary buildings at the New York World's Fair should be given serious consideration. Its effect on steel conservation would be expedited by promulgating the sections progressively, starting with the most important ones, such as "loads and stresses" and structural design. During the life of this manual, i. e., during the period of national emergency, a standing committee should be active in keeping the document up to date and in rewriting sections which may appear incongruous or subject to later improvement.

The Board also feels that a reduction in the amount of steel used in bridge construction may be effected by the following provisions:

1. That the 1941 edition of the Specifications for Steel Railway

Bridges of the American Railway Engineering Association be recognized as the standard for the design of railway bridges, and the 1941 edition of the Standard Specifications for Highway Bridges of the American Association of State Highway Officials be the standard for the design of highway bridges.

2. That a careful study be made of actual load requirements for each structure, and the minimum live load consistent with such requirements adopted.

3. That, in the making of layouts and working out the designs of bridges, the most careful economic studies be made in order to reduce the weight of steel to a minimum.

4. That the use of plates be reduced to a minimum; and where their employment is unavoidable, that the widths be kept to 48 in. or less where practicable.

5. That the use of steel not required by computed stresses, as in fascias and other architectural members and in increased thicknesses to provide against loss of metal by corrosion, be reduced to a minimum; and that houses, walkways, and other accessory portions, in which steel construction would normally be used, be made of timber, concrete, or other readily available materials.

The Board has no recommendations, at the present at least, as to your request for recommendations as to maximum roof and crane way spans. Before commenting on this question, it should be further developed and elucidated by you and/or other officers of the OPM.

Yours very truly,

ENGINEERS' DEFENSE BOARD
R. E. McConnell, *Chairman* A. B. Parsons, *Secretary*

1942 Program of Meetings Completely Revised to Emphasize War Effort

IN THE spirit of cooperation with the war effort, a radical change has been voted by the Board of Direction with regard to the quarterly meetings of the Society to be held in this year 1942.

It had been planned that the Spring Meeting would be held in New Orleans, the Summer Convention in Spokane, and the Fall Meeting in Atlanta. However, the Board of Direction believes that this is a year in which the Society should relieve its members of all possible burdens incident to the planning and preparation of quarterly meetings. Ordinarily, a single Local Section acts as a gracious host to the whole Society.

Instead the Board of Direction has decided that intensive application should be devoted this year to the national emergency, and has asked the executive committees of the Technical Divisions to prepare programs which will have this as their aim. The Board has decided also that the meetings shall be held without expense to any Local Section of the Society. The meetings are to be near centers of population and at places where none of the members will feel themselves called upon to give the time, energy, and money which usually go into the preparations for meetings.

The staff and Technical Divisions together are to arrange the meetings, which will be held in cities, not yet selected, where a suitable hotel can be found, or perhaps at a resort, or possibly a college campus, that is easily accessible and possessed of such facilities as will provide all necessary entertainment. Under this arrangement the Technical Divisions will be able to concentrate their entire attention on the type and subject matter of their sessions. Attention will be focused on engineering experience in emergency construction, design, or operations, or in other fields, that are of the greatest value in connection with the war effort.

News of Local Sections

Scheduled Meetings

CLEVELAND SECTION—Luncheon meeting at the Guildhall on February 2, at 12:15 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers' Club on February 16, at 12 m.

DISTRICT OF COLUMBIA SECTION—Meeting at the Cosmos Club on February 17, at 8:15 p.m.

ILLINOIS SECTION—Dinner meetings of the Junior Section at the Central Y.M.C.A. on February 3 and February 16, at 6 p.m.

IOWA SECTION—Talk at the Roosevelt Hotel, Cedar Rapids, Iowa, on February 10, at 8 p.m.

ITHACA SECTION—Dinner meeting at the Willard Straight Hall, Ithaca, on February 10, at 6:30 p.m.

KANSAS CITY SECTION—Dinner meeting at the Continental Hotel on February 7, at 6:30 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building on February 18, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Alcazar Hotel on February 5, at 7 p.m.

MICHIGAN SECTION—Joint meeting with the Toledo Section in the Engineering Societies of Detroit Building on February 5, at 8 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on February 2, at 6:30 p.m.; dinner meeting of the Junior Chapter at Mrs. Bryan's Tea Room on February 17, at 6:30 p.m.

PHILADELPHIA SECTION—Social evening at the Engineers' Club on February 21, at 6 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.; dinner meeting of the Junior Forum at Hart's Restaurant on February 11, at 6 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club of San Francisco on February 17, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers' Club on February 23, at 6 p.m.

TACOMA SECTION—Dinner meeting at the Lakewood Community Center on February 10, at 6:30 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville Sub-Section at the S. & W. Cafeteria on February 10, at 5:45 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on February 2, at 12:10 p.m.

TOLEDO SECTION—See MICHIGAN SECTION.

Recent Activities

CENTRAL OHIO SECTION

On November 13 the members of the Ohio State University Student Chapter were guests of the Section at the twentieth anniversary celebration of the founding of the Section. Since the account of the meeting was submitted by the secretary of the Chapter, the write-up appears under the head of "Student Chapter Notes."

ILLINOIS SECTION

On December 5 the Juniors of the Illinois Section sponsored a joint dinner meeting with the Section. The guest speaker was Eugene Callendar, of the Illinois State Employment Department, who spoke on the subject, "Crime from Inside Out." Clifford R. Krabbenhoft, president of the Juniors, was master of ceremonies.

New officers for the Illinois Section—elected on December 19—are H. P. Ramey, president; J. F. Seifried and Craig P. Hazelet, vice-presidents; G. S. Salter, secretary; and C. R. Ege, treasurer.

INDIANA SECTION

As usual the Indiana Section participated in the two-day annual meeting of the Indiana Engineering Council, which was held in Indianapolis on November 28 and 29. About fifty members of the Section attended the various sessions, and President L. E. Martin presided at the informal luncheon on Friday. Another member of the Section—W. A. Knapp—presided at the afternoon technical session, which was addressed by Henry Hutchings, Jr., lieutenant-colonel, Corps of Engineers, U.S. Army. Colonel Hutchings, who is district engineer at Louisville, Ky., spoke on "Construction for Defense." He also discussed the forthcoming

consolidation of the Construction Division of the Quartermaster Corps and the Corps of Engineers, outlining the working arrangements in general and methods in which contractual services will be handled. The speaker at the evening dinner meeting was Maj. Francis J. Wilson, who is in the Office of the Chief of Engineers, Washington, D.C. Major Wilson's subject was "Air Raids and Protective Construction."

ITHACA SECTION

On November 24 the Section met on the Cornell campus with the Cornell University Student Chapter for dinner and a technical program. The latter consisted of a talk—on the pioneer work of the U.S. Geological Survey in Alaska—by C. C. Covert, New York representative of W. and L. E. Gurley.

A joint dinner meeting of the Section and the Steuben Area Chapter of the New York State Society of Professional Engineers took place in Elmira, N.Y., on December 9. An illustrated lecture on the cable construction of the Golden Gate Bridge was the feature of the occasion. This was given by Blair Birdsall, assistant chief engineer of the John A. Roebling and Sons Company, of Trenton, N.J.

KENTUCKY SECTION

At the annual dinner meeting of the Section, held in Frankfort on December 12, the following officers were elected for the coming year: C. H. Blackman, president; R. E. Shaver, vice-president; and S. M. Bailey, secretary-treasurer. The technical program for the occasion consisted of a paper on the "Design of the Clays Ferry Bridge," presented by E. D. Smith, assistant bridge engineer for the Kentucky State Highway Department. Mr. Smith pointed out that the bridge, when completed, will be one of the highest highway bridges in the United States and will constitute a major improvement in one of the main north-and-south roads of the state.

LOS ANGELES SECTION

A symposium on the "Hueneme Harbor Development—presented by A. F. Barnard, Los Angeles consultant, and his associates—was the feature of the December 10 meeting of the Section. Mr. Barnard described the legal aspects of the development and the difficulties encountered in getting government appropriations for the project, the result being that it was finally financed by private subscription. Historically, Hueneme was one of the largest ports in California for the shipment of wool and various farm products. It was not until recently, however, that the port was developed for present-day ocean commerce. Motion pictures were to have accompanied the symposium, but Los Angeles' first blackout prevented their being shown.

METROPOLITAN SECTION

"Relieving Platform Bulkhead Walls" was the subject of discussion at the December meeting of the Metropolitan Section. The principal speaker was Lester C. Hammond, chief engineer of the Borough of Manhattan, who discussed in detail the improvements in design and construction of bulkhead wall along the waterfront for the East River Drive. Numerous, varied, and troublesome problems were encountered, and the paper described the methods employed to overcome these obstacles and carry the work to a successful conclusion. The discussion following the formal presentation brought out the essential difference between the gravity type of bulkhead wall and the relieving platform type which must be employed where confronting waterfront conditions render the former type impracticable. At this meeting the Section was host to the members of the eight Student Chapters in the Metropolitan Area.

MID-MISSOURI SECTION

At the fall meeting of the Mid-Missouri Section, held in Columbia on November 3, Prof. H. W. Wood, Jr., reported on the Chicago Meeting of the Society. His review of Commissioner Binger's account of his recent trip to England proved of special interest. The speaker of the evening was Brig. Gen. A. McIntyre, commandant of the R.O.T.C. Regiment of the University of Missouri, who discussed the progress of the war to date, emphasizing the necessity for an allied victory. A review of recent timely articles in CIVIL ENGINEERING—presented by James D. Gofourth, president of the University of Missouri Student Chapter—concluded the evening. A number of students from the University of Missouri and Missouri State College Chapters were guests of the Section on this occasion.

NEBRASKA SECTION

The program presented at the annual meeting of the Nebraska Section, which took place in Omaha on December 9, consisted of a talk on the operation of a newspaper. This was given by Edwin Landale, Sunday editor of the *Omaha World Herald*. During the business meeting the following new officers were elected for the coming year: Guy P. Dorsey, president; D. H. Harkness, senior vice-president; and E. W. Woodbridge, junior vice-president. H. G. Schlitt will continue as secretary-treasurer.

NORTHEASTERN SECTION

On November 13 the Northeastern Section met at Massachusetts Institute of Technology for a joint dinner with the Boston section of the American Society of Mechanical Engineers. The feature of the occasion was a talk by W. P. Homans, coordinator of the Eastern District Priorities Field Service of the Office of Production Management. Mr. Homans, who has been in the New England office of the Priorities Division since its establishment, outlined the development of the Division, its purpose and organization, as well as the principles involved in the use of priorities to facilitate the defense program. Mr. Homans declared that priorities are probably reaching the limit of usefulness, at least as far as some fields are concerned. Allocation has already taken place in the distribution of some of the scarcer materials, and this rationing will undoubtedly become more general as time goes on.

OREGON SECTION

A technical meeting of the Section was held at the Portland plant of the Oregon Shipbuilding Company on December 10. After dinner in the company cafeteria, the group went to the molding loft where a detailed scale model of the type of cargo vessel being built in the yard was explained at some length. Following this, there was a general inspection of the plant's shop, ways, outfitting docks, and so on.

PHILADELPHIA SECTION

The December meeting was given over to a discussion on civilian defense, with Charles Haydock as master of ceremonies. The first speaker was Hubley R. Owen, chairman of the Philadelphia Council of Defense, who described the defense set-up in Philadelphia. Dr. Owen stated that there are air-raid wardens for every 500 people, and that the wardens are trained to give first aid and to evacuate civilians if necessary. Secretary George T. Seabury then presented certificates of life membership to eight members of the Section, and introduced James E. Jagger, new Field Secretary of the Society, to the membership. The second speaker on the technical program was E. R. Davis, special agent for the Federal Bureau of Investigation, who discussed the Bureau's investigation of sabotage, "fifth columnists," espionage, and propaganda in the United States. Then Sherwood B. Smith, of the U.S. Corps of Engineers, who has recently returned from England, gave an interesting account of conditions there. "Static tanks at strategic locations are being constructed all over London," Mr. Smith stated. "They have been a great help in reducing fire losses." He also pointed out that damage to bridges in England has been slight, and interruptions to railroad traffic few. As a final word, he stressed the importance of cool-headedness, if any civilian defense effort is to be successful, saying that "the greatest danger in air raids is hysteria of the population." The showing of two motion pictures produced in England—"Britain on Guard" and "Behind the Gun"—concluded the program.

ST. LOUIS SECTION

At the annual meeting of the St. Louis Section, which took place on December 12, the following new officers were elected: Hymen Shifrin, president; R. W. Hodson, vice-president; and M. Buckmueller, secretary-treasurer. The technical program for the occasion consisted of talks by Frank J. McDevitt, manager of the St. Louis office for Contract Distribution, and Frank W. Herring, assistant director of the National Resources Planning Board. The former discussed the work of his organization, while Mr. Herring spoke on the subject of "Planning Public Works for the Post-War Period," emphasizing the fact that the high level of national income must be maintained if victory is to be complete. Mr. Herring stated that a properly planned program of public works will fill a large gap in the inevitable post-war slump and indicated that efforts are now being made to avoid another depression period.

SAN FRANCISCO SECTION

The technical program at the annual meeting of the Section, which took place on December 13, consisted of a "Report of Tests of Exposition Timber Trusses and Joints" by John J. Gould, and a "Report of the Committee on Tests of Exposition Building Details" by Harold C. Hammill. Mr. Gould described the test program as completed to date and outlined, with the aid of lantern slides, the results of tests of various timber trusses and joints, which were taken from buildings and other structures demolished on Treasure Island. The test program is sponsored by the Section and has been financed by the lumber industries and, as a research project, by the WPA. A recent allotment from WPA assures a continuation of the test program. The new officers elected at this time are F. E. Bonner, president; Samuel B. Morris, senior vice-president; and T. J. Corwin, Jr., junior vice-president. E. M. Knapik will continue as secretary-treasurer.

Recent activities of the Junior Forum include a pre-Christmas dinner dance, which took place on December 12, in spite of a lengthy blackout that evening. At the November meeting Blair Burnson spoke on the water purification activities of the East Bay Municipal Utility District, of which he is assistant sanitary engineer. The topic for general discussion was "To What Extent Should the Federal Government Inform the Public of Activities of Military and Naval Forces?" The Forum announced that it has successfully completed its second annual series of seminars for preparation for the state license examination.

TENNESSEE VALLEY SECTION

A regular dinner meeting of the Chattanooga Sub-Section was held on December 9. The program for the occasion consisted of a talk—accompanied by a moving picture in color—on the subject, "Laboratory and Field Control for Rolled-Fill Embankments." The speaker was M. N. Sinacori, associate materials engineer for the TVA on the construction of Kentucky Dam, assisted by G. P. Jessup, project manager at Kentucky Dam.

Wives and children of members of the Knoxville Sub-Section were invited to a Christmas party on December 16. The program, which had been arranged by Prof. E. S. Fabian, included contests, group singing, and a brief talk by D. M. Wood on his hobby of collecting unusual epitaphs. In addition to Christmas films for children, there was a picture of the development of wild life in the Tennessee Valley, taken by the Tennessee Valley Authority Biological Readjustment Division. All agreed that it was an enjoyable type of meeting and voted to make it an annual event.

WISCONSIN SECTION

At the annual meeting—held in Milwaukee on December 11—the following new officers were elected for the coming year: Berry E. Brevik, president; Herbert H. Brown, first vice-president; Arthur L. Boley, second vice-president; and Lloyd D. Knapp, secretary-treasurer. Announcement was made of the Section's annual award of Junior membership in the Society. First prize goes to John Kenneth Holcomb for his paper on "Geology of Milwaukee County—Overburden," and second prize to Herbert N. Amrhein for his paper on "Photography for the Engineer." Both recipients are members of the Marquette University Student Chapter. The technical program consisted of the showing of two sound films—one on the new Ford army cars, and the other on Yellowstone National Park.

Student Chapter Notes

BROWN UNIVERSITY

The Chapter's fourth meeting of the season—held on December 10—was devoted to business discussion and a student talk. The speaker was I. W. Patterson, Jr., who discussed the foundations for the Cleveland Union Station. He described the many hazards encountered during the construction of the foundations, which are of the open-well type, and explained how they were remedied.

NEW YORK UNIVERSITY

"Design Features of Structural Sections" was the subject of discussion at the December meeting of the New York University Student Chapter. The principal speaker was Milton Male, research engineer for the U. S. Steel Corporation of Delaware. Mr. Male discussed the design characteristics and normal properties of I- and H-beams, comparing the American and British standards, and the American wide-flange I-beams. The lecture was illustrated with slides, and the discussion that followed was concerned with the new OPM restrictions upon steel production.

RUTGERS UNIVERSITY

At the December meeting of the Rutgers Chapter Dr. Rudolphs, a graduate student at the university, spoke on "The Engineer as a Public Expert." When an engineer testifies as an expert in court, Dr. Rudolphs pointed out, "he should be at all times calm; he should exercise self control; and he should present his case in a logical way."

OHIO STATE UNIVERSITY

Continuing their "keep acquainted" policy, the Ohio State University Student Chapter and the Central Ohio Section met jointly on November 13 for what proved to be one of the most outstanding gatherings of recent seasons. The occasion marked the twentieth anniversary of the founding of the Section, and a birthday cake with candles was brought in at the close of the banquet. The cake was then raffled off at ten cents a slice, the proceedings providing a welcome gift to the Chapter. After dinner President C. V. Youngquist called upon Prof. C. T. Morris to say a word about each of the past-presidents of the Section and introduce those of the group who were present. James E. Jagger, new Field Secretary of the Society, then took the floor as the main speaker of the evening. Mr. Jagger discussed the organization and functioning of the Society and the place of the student in the Society. The accompanying group photograph was submitted by John R. Bayliss, secretary-treasurer of the Ohio State Student Chapter.

THE CENTRAL OHIO SECTION AND OHIO STATE CHAPTER CELEBRATE 20TH ANNIVERSARY OF THE SECTION

ITEMS OF INTEREST

About Engineers and Engineering

CIVIL ENGINEERING for March

MODEL studies on all hydraulic problems connected with the Panama Canal are carried on in the Canal's Hydraulic Laboratory, made necessary by the Third Locks project. This laboratory and its functions will be described by F. W. Edwards, senior hydraulics engineer of the Canal.

"Coordinating Design and Construction on the Chicago Subway" is the title of a paper by Peter F. Girard, assistant chief engineer of the city's Department of Subways and Superhighways. He tells how 60 million dollars worth of subway was brought to completion in less than four years.

Of practical usefulness to the busy engineer is the contribution by Gustav E. Larson on "Research for Flood Control Data." Much valuable information is buried in old newspaper files, specialized libraries, and Government archives and Mr. Larson shows how to find it.

In the construction field, E. A. Burt describes the building of the Angeles Forest Highway in California, through the rugged San Gabriel range.

Simplification of Steel Shapes

A SIMPLIFIED list of sections, entitled "Simplification of Structural Steel Shapes," has been prepared by the American Iron and Steel Institute. This revised list is in accordance with the instruction of the Office of Production Management, which has requested the elimination of non-essential and unnecessary structural shapes in the interest of maximum mill production and steel conservation.

Copies of the list can be secured from the American Iron and Steel Institute, 350 Fifth Avenue, New York, for 25 cents.

Message from Cuba

ON December 8 the president of Sociedad Cubana de Ingenieros, José Garcia Montes, wrote to the President of the Society pledging the cooperation of that organization in our war effort. He wrote:

"As president of this society and a member of the American Society of Civil Engineers, I wish to express my deepest sympathy to my fellow members, citizens of the United States, now in war with Japan, and assure them that my country will take action as required, by their side, affording us Cuban engineers the opportunity to play our part in war and defense.

"This letter is a heart message from the Cuban engineers, members of Sociedad Cubana de Ingenieros, to their brethren, the members of the American Society of Civil Engineers. We are a small group in comparison with your great Society, but we are anxious to help and no other such group anywhere can boast of a more sincere desire."

Prof. N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

AT ITS February session, our Engineers Club looked and spoke more like a conclave of military than civil engineers. We stood to salute the flag and recite our creed, with determination as well as formal dignity. Quick assets in our reserve were voted into defense bonds. Philippine strategy was discussed over the coffee. Then Professor Neare interrupted.

"Let's not forget that we left 709,639,444,801 Slavs recovering their rifles and helmets at random on their field of battle, nor that they have turned the invaders after many months of moments darker than ours, nor that they could relax battle tension to wager on the chance that at least one would repossess his own rifle or his own helmet. The matter of fair odds for the wager was Guest Professor Jenney's problem, and he is here tonite, ready for argument."

Lee High claimed the floor. "I figured Ivan Uffoff was nearest right with odds of one kopec to 16 chervonetzen, more so if he meant paper kopecs and gold chervonetzen. The correct odds were one to 354,819,722,400—about the same as for a Republican race driver trying to buy a new tire."

"That's taking the words right out of my mouth," exclaimed Si Lowe. "I make the 'odds-on' the ratio of $2n - 1$ to $(n - 1)^2$, which, for large numbers, is nearly one to $\frac{1}{2}(n - 1)$. Unless Igor had his own helmet spotted and was betting on a sure thing, he was wilder than drawing to a two-flush."

"Two wrong so far," judged Professor Jenney. "Any other comers?" But silence was the wary reply.

"I don't wonder," he continued, "since our minds are more concerned with the chances of MacArthur at Corregidor. So I'll tell you the answer and leave the proof for your leisure. Here's a table that will interest you."

SLAVS	ODDS-ON
2	3
3	8
4	6.1111
5	6.4380
6	6.3820
7	6.38995
8	6.38896
709,639,444,801	6.38906

"For any number of Slavs, the odds-on can be expressed,

$$\frac{1}{\left[\sum_{x=2}^{n} \frac{(-1)^x}{x!}\right]^2} - 1 \xrightarrow[n=\infty]{} e^2 - 1$$

so Igor's 6.25 (one ruble to 16 kopecs) was fair. A 2% advantage is a reasonable bonus for honest wit. Do you agree, Noah?"

"Absolutely, with the reservation that Igor might also have a bonus for knowledge of psychology. Many or most of the Slavs would try several helmets for a fit, increasing the chances of repossession. Now for a problem pertinent to our own war.

"Aaron Ottix, the Consulting Airport Engineer, has just been engaged to locate and design twelve S-C-Type (Super-Colossal) Air Bases, from which our B-19's can cruise the whole earth. Maximum cruising radius for complete coverage must be held to a minimum to conserve pay-load capacity. Tokyo must be within range from three bases.

"Aaron says he has made the problem definite by spotting one base due south of Tokyo and admits some S-C bases will be floaters. Assuming the B-19 cruises at 3,964 miles from the geocenter, how would you locate the sites and what must be the effective cruising range?"

(Professor Neare appreciates the interest expressed by reams of wrong answers to the December problem. So many were anonymous that error must have been suspected. Lee High, Si Lowe, and Aaron Ottix are all fictitious, of course.)

Advisory Board on Civilian Defense

A RECENT announcement from the Office of Civilian Defense calls attention to the fact that members of the National Technological Civil Protection Committee—appointed by the Secretary of War in January 1941—have agreed to act also as Advisory Board on Sanitary and Public Health Engineering to the Medical Division of the Office of Civilian Defense. The personnel of the new committee includes the following members of the Society: Walter D. Binger, chairman, E. M. Hastings, Harry E. Jordan, W. Cullen Morris, and Abel Wolman. The Office of Civilian Defense will have a contact member on the committee as does the War Department.

Regional sanitary engineers are being appointed by the Medical Division to work, through State Defense Councils, with state health departments in planning defense against belligerent action. Most important of their duties will be the promotion of protective measures for public water supplies, which may be subject to destructive enemy action. The engineers will also consult with health authorities on such matters as emergency maintenance of sewerage, sanitary facilities, garbage disposal, and protection of milk and food supplies in the event of a disaster.

Regional sanitary engineers already on duty include Gordon E. McCallum, M. Am. Soc. C.E., who has been commissioned in the Public Health Service Reserve and assigned to the Third Civilian Defense Region.

NEWS OF ENGINEERS

Personal Items About Society Members

D. F. GIBONEY has resigned as director of the WPA Division of Training and Reemployment at Long Island City, N.Y., in order to engage in defense work at Basra, Iraq, where he will be assistant chief engineer for Spencer, White and Prentis.

A. O. VAN SUETENDAEL was recently elected a member of the New York Stock Exchange and has just formed the firm of A. O. Van Suetendael and Company at 20 South Broadway, Yonkers, N.Y. The firm will be successor to the business that Colonel Van Suetendael has been conducting as one of the oldest Westchester County (N.Y.) dealers in securities.

F. J. BIELE is now doing defense work for the Caribbean Architect-Engineer, with headquarters in New York City.

ROBERT L. MAYNARD has resigned as general superintendent of the Asheville (N.C.) Water Department in order to become office engineer at Atlanta, Ga., for the Portland Cement Association. Part of Mr. Maynard's duties at Asheville will be assumed by FRANK B. CAMPBELL, formerly associate engineer in the U.S. Engineer Office at Nashville, Tenn., who will have the title of maintenance engineer.

RICHARD DE CHARMS, lieutenant commander, C.E.C., U.S. Naval Reserve, Philadelphia, Pa., has been assigned as resident naval officer in charge of construction at the Cunningham Field marine air base now under construction at New Bern, N.C.

JOSEPH P. LAWS, member of the TVA staff since 1934, has been made assistant construction engineer at Watts Bar Dam, Tenn.

ROSS C. KEELING was recently promoted from the position of engineer of construction for the Kansas State Highway Commission to that of State Highway engineer. Mr. Keeling, who has been with the State Highway Commission since 1929, succeeds the late R. B. WILLS.

T. H. CARVER retired on November 28 as assistant city engineer of Seattle, Wash., after thirty-six years in the service of the city.

JOHN C. PRITCHARD, major, Corps of Engineers, U.S. Army, has been assigned as assistant constructing quartermaster on the construction of a detonator plant at Jacksonville, Ark. Until recently Major Pritchard was engineer officer in the Constructing Quartermaster's Office at Omaha, Nebr.

PHIL MITCHELL, 2d, is now working on a base for the U.S. Government at Trinidad, B.W.I. Since his graduation from Duke University in 1940, Mr. Mitchell has been field engineer for the Walsh Construction Company, of Davenport, Iowa.

JOSEPH MARIN, until recently associate professor of civil engineering at the Illinois Institute of Technology, has been appointed professor of engineering mechanics at Pennsylvania State College. He will begin his new work on February 1.

N. W. REMLEY, major, Corps of Engineers, U.S. Army, has been assigned to a project at Louisiana, Mo., where he will be assistant constructing quartermaster.

DONALD S. TETER has been promoted from the position of field supervisor in the Bureau of Street Construction, Milwaukee, Wis., to that of assistant superintendent.

HERBERT D. VOGEL, major, Corps of Engineers, U.S. Army, is now chief of the engineering division of the U.S. Engineer Office at Pittsburgh, Pa.

DECEASED

ROBERT HARE POWEL CORLEY (Assoc. M. '36) designing engineer for the Philadelphia Rapid Transit Company, Philadelphia, Pa., died on December 8, 1941. Mr. Corley, who was 55, had been with the Philadelphia Rapid Transit Company in varying capacities since 1920. Earlier in his career (1911 to 1916) he was a designer for the Interborough Rapid Transit Company in New York City, and from 1916 to 1919 for the Midvale Steel Company, of Philadelphia.

GEORGE DURNO COWIE (M. '34) hydraulic and geodetic engineer for the U.S. Coast and Geodetic Survey, was killed in an air raid at Manila on December 24, 1941. Commander Cowie, who was assigned as director of coast surveys in the Philippines last March, had been connected with the Coast and Geodetic Survey since 1910. He had conducted surveys on both coasts of the United States and in Alaska and was serving his second assignment in the Philippines. From November 1917 to February 1919 he served in France with the Field Artillery and was orientation officer during the Argonne offensive.

JOHN HENRY DOCKWEILER (M. '06) consulting engineer of Los Angeles, Calif., died in that city on December 21, 1941, at the age of 77. For six years Mr. Dockweiler acted as city engineer of Los Angeles, and for twelve years as consulting engineer to the city attorney of San Francisco. From 1906 to 1916 he was consultant to the Oakland (Calif.) city attorney.

JOSEPH ALEXANDER DONAHEY (Assoc. M. '07) manager of sales for the Cleveland Frog and Crossing Company of Cleveland, Ohio, died on December 8, 1941. He was 63. Before the World War Mr. Donahey served for seven years as chief engineer and general superintendent of the Akron, Canton and Youngstown Railroad. During the war he was captain of Company C, 147th Engineers, stationed at Fort Benjamin Harrison in Indiana. He then became sales and service engineer for the Cleveland Frog and Crossing Company, being promoted a few years later to the post he held at the time of his death.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

HAROLD CHAMBERLAYNE FISKE (M. '24) colonel, Corps of Engineers, U.S. Army (retired), died at his home at Manhasset, N.Y., on January 8, 1942. Colonel Fiske, who was 61, was active in the Corps of Engineers in charge of the Rivers and Harbors Division. He had served as chief of the Tennessee Valley Power Survey, and was on the New York City Board of Transportation on the building of the Eighth Avenue Subway. During the World War he commanded the 107th Engineers Regiment of the 32d Division overseas, receiving the Croix de Guerre and other decorations. He retired from active service in 1930 because of a heart ailment.

WILLIAM BARKER LANDRETH (M. '88) consulting engineer of Schenectady, N.Y., died on December 9, 1941, at the age of 84. From 1897 to 1922 Mr. Landreth was in charge of engineering work for Schenectady, Jamestown, and several other cities in New York and for part of this period (1897 to 1911) was, also, in the New York State Engineer Department as assistant, resident, or special deputy state engineer on plans for, and construction of, the Barge Canal. Later he was city engineer of Schenectady, and from 1915 to 1919 deputy state engineer. He had been in general practice since 1922. A veteran member of the Society, Mr. Landreth served as Director from 1905 to 1907.

JOSEPH DANIEL LIX (Jun. '37) junior civil engineer for the WPA in Washington, D.C., died on June 6, 1941, though word of his death has just reached the Society. Mr. Lix, who was 27, graduated from the Catholic University of America in 1937. He had been connected with the WPA for some time.

FRANCIS LEWIS SCHAFFEL (Jun. '37) of Richmond Hill, N.Y., was killed on December 4, 1941, when the Hartford (Conn.) Bridge on which he was working collapsed. He was 25. Since his graduation in 1937 from the College of the City of New York Mr. Schaffel had been an assistant engineer in the erection department of the American Bridge Company, having worked on the Bronx-Whitestone Bridge, the Lorain (Ohio) Bridge, and several other structures.

MURRAY SULLIVAN (M. '13) who recently accepted a position as assistant area planning engineer for the Utah Public Work Reserve, died in Salt Lake City, Utah, on December 14, 1941. He was 60. From 1906 to 1915 Mr. Sullivan was office engineer for the Oregon Short Line Railroad; from 1916 to 1922 chief engineer of the American Railroad Expedition to China; and from 1923 to 1938 general manager for the Salt Lake and Utah Railroad. During his stay in China he was one of the organizers of the Association of Chinese and American Engineers, and general manager of the Chinese Engineering and Development Company.